The time of working, corresponding to this average is 13 hours. The weight on the safety-valve is 4½ lb. per square inch.

The engines and machinery at Blackwall are similarly arranged, but on a smaller scale. The railway there passes by the side of the engine-house on the ground, and therefore the ropes are gathered on at the lowest part of the circumference of the drums, instead of at the highest part, as at the Minories, where the railway passes over the engine-house. The engines, constructed by Mr. Barnes, are of the marine side-lever form, of the nominal forces of 70 horse-power each, the pistons are 45½ inches diameter, with 4 feet stroke, and their average speed is 25 strokes per minute. The large spur-wheels are 17 feet diameter to the pitch line, with 120 teeth, 5⅓ inches pitch, and 14 inches broad, working into mortice spur-wheels on the axes of the drums, 10 ft. 10 in. diameter, with 80 wood cogs. The drums are 16½ feet diameter when empty, and 22 feet diameter outside. The small steam-engine for working the air-pumps, is 8 horse-power; it was constructed by Messrs. Miller and Ravenhill.

*Remarks made at the Meeting after the reading of the above Paper.*

Mr. Farey stated that the wire rope consisted of six strands, each of six wires, coiled round a hempen core, and the whole of the strands were also laid round one centre core of hemp. Wherever the wires were in actual contact with the core, corrosion appeared to take place, which of course augmented the rapidity of the destruction of the rope. It was, however, now merely a question of expense, as, since the adoption of the wire rope, breakage seldom occurred. He thought that the old hempen rope had frequently been broken by the undue strain which was suddenly brought upon it, by its slipping on the drum. He imagined that a modification of the method used in cotton spinning for regulating the coiling of the filaments, might be adopted with advantage, instead of as at present coiling it by hand.

Mr. Bidder said he had noticed the peculiar tendency of the hemp rope to twist, which caused its frequent fracture. The first rope was 5½ inches in circumference, with a lay of 4½ inches; this was soon diminished to 3 inches, and it broke continually. It was replaced by a rope from which the tar had been expelled by pressure; that was soon worn out, and the fibre appeared completely destroyed. Wire ropes of various kinds were then tried; and at last, by the introduction of swivels, and recently by an improved construction of them, the bad effects of the twisting were obviated, although it still took place. In spite of the rapid destruction of the hemp rope, he was of opinion, that as a mere question of cost, it would be found cheaper than wire rope, as, when partially destroyed, the former had still a certain value, but the latter was comparatively valueless.

Mr. R. Stephenson stated that he was unable to account satisfactorily for the twisting of the rope. He imagined that it might be caused, in some degree, by its being coiled over the drum at the Minories end, and under the drum at the Blackwall end of the railway. The lateral action of the groove of the inclined guide pulleys might also influence it, particularly on the sharpest curves. Ropes composed of lengths, with a right-hand and a left-hand lay alternately, had been tried, but ineffectually; the twisting still continued, and the bad effects were only counteracted by the swivels. It might have been imagined that the rope would have untwisted, and thus have lengthened; but, on the contrary, it became more tightly twisted, its diameter diminished, and still its length increased, apparently from the pull of the engines upon it. It was evident from the appearance of the fracture, when one occurred, that the material was wrenched asunder by a twisting action. The breakages occurred, however, very seldom at present; not oftener than once or twice in a month, during which time nearly three thousand journeys were made, and then they arose generally from the carelessness of the breaksmen, who, it must be remembered, received their instructions from a distance of three miles, by the electric telegraph. The were six swivels in the rope, one at every half-mile. The destructive effects of the twisting would probably be diminshed by a larger number of swivels, but they were very objectionable, in preventing the regular laying of the rope upon the drum. On the inclined planes in the north of England, where ropes had been used for many years, this twisting was not observed; but there the engines were at one end only; whereas, on the Blackwall railway, the engines at both ends working simultaneously, might probably have a tendency to cause the twisting. Twenty years ago he had tried, in the North, machinery similar to that suggested by Mr. Farey, for laying the rope on the drum; but in consequence of the general diminution of diameter of the rope from the stretching, and the inequalities occasioned by the splices, the machinery was constantly put out of order, and was eventually destroyed. On the Blackwall line, the men had acquired considerable dexterity in directing the rope with the levers or shears, and he thought it would scarcely be possible to improve that part of the system.—Some difficulty had been apprehended from the use of condensing engines, on account of the time required for forming the vacuum; it had, however, been met by having a small engine constantly working to keep up the vacuum and to pump water. High-pressure engines were generally used with rope traction, in order to avoid this difficulty. He, however, preferred the use of condensing engines, with a small supplementary engine, and believed them, at the same time, to be more economical.

Mr. A. Wightman stated that the wire rope was manufactured by Messrs. Newall, of Gateshead. The wire was unannealed, and the weight of the rope was 10 lb. per fathom, except two lengths of half a mile each, which weighed 12 lb. per fathom; these lengths were so placed, that the main trains to or from Blackwall, were always attached upon them. The swivels were at first rivetted into the rope, but it was found that at least two-thirds of the fractures of the rope occurred where the first rivet was inserted. In order to prevent this, the swivels were spliced into the rope; this was done by unstranding about a yard and a half of the rope, passing the strands through an eye in the swivel, and then splicing them back into the rope. Swivels thus inserted would last three months without renewing, and the lay of the rope had been preserved by them. Breakages, however, still occurred, but (except from carelessness), they rarely, if ever, took place in a rope less than a year old; after that time the rope began to lose its strength, from the oxidation that took place, wherever the strands came in contact with the hemp core, and although a rope might appear sound after it had been in use for a year and a half, yet on opening it, a considerable extent of oxidation would be discovered. The rope-makers in the North attributed this, in a great measure, to the serving of the rope with spun yarn, which had been adopted on the Blackwall railway, chiefly to prevent the noise occasioned by the rope passing over the sheaves. Experiments were in progress, with a view to doing away with the serving of the rope, by covering the sheaves with hard leather, which, if successful, would be the means of saving the company a large expense in keeping up the serving, and would take a weight of about 12 tons off the engines, and reducing also the cost of fuel. With regard to hempen ropes, both tarred and white ropes had been tried, but they had totally failed; some of them not lasting more than two months. These ropes had a great tendency to twist, and from their bulk it was very difficult to counteract it by the insertion of swivels. The wire ropes were, consequently, the cheapest; for although there was a difference in the original cost, as also on the return for the old ropes, yet the duration of the wire rope was so much greater, that it more than compensated for the increase in price.

The charges for the motive power, for the year 1845, amounted to £11,302 1*s.* 2*d.*; during that time there were run 105 trains per day, 3¾ miles each, or 38,325 trains per annum, at an average cost of 5*s.* 10¾*d.* per train, or 1s. 6¾*d.* per mile.

Although the present cost of working the line by the rope system was high, yet by no other system had they been able satisfactorily to effect the accommodation of stopping at the various stations, without interfering with the "through traffic."

## FOSSIL FOOTMARKS IN THE COAL FORMATION.

Mr. Lyell delivered a lecture at the Royal Institution, on February 4th, "*On the Fossil Footmarks of a Reptile in the Coal Formation of the Alleghany Mountains.*

Mr. Lyell began by observing that, notwithstanding the numerous remains of land plants in the carboniferous strata and the evidence they afford of the existence of large tracts of dry land (the exact position of which is often indicated by seams of coal and buried forests), no monuments of any air-breathing creatures had been detected in rocks of such high antiquity until Dr. King, in 1844, published his account of the foot-prints of a reptile occurring in sandstone in Pennsylvania (see *Silliman's Journal*, vol. 48, page 343). These fossil tracks were found in a stone quarry five miles south-east of Greensburg, and about twenty miles east of Pittsburgh, appearing on the under surfaces of slabs of argillaceous sandstone extracted for paving. They project in relief, being casts of impressions formed in a subjacent layer of fine unctuous clay, and they are accompanied by numerous casts of cracks of various sizes, evidently produced by the drying and shrinking of the clayey mud. These cracks occasionally traverse the foot-prints, showing that the shrinkage took place after the animal had walked over the soft mud, and before it had begun to dry and crack. Mr. Lyell exhibited a slab which he had brought from the quarries, having visited them with Dr. King; and then proceeded to point out the differences between these foot-prints and those of the European cheirotherium found in Saxony and in Warwickshire and Cheshire, always in the upper part of the new red sandstone or trias. In the European hand-shaped foot-marks, from the form of which the animal was called by Kaup, cheirotherium, both the hind and fore feet have each five toes, and the size of the hind foot is about five times as large as the fore foot. In the American fossil the posterior foot-print is not twice as large as the anterior, and the number of toes is unequal, being five in the hinder and four in the anterior foot; as in the European cheirotherium the fifth toe stands out nearly at a right angle with the foot, and somewhat resembles the human thumb. On the external side of all the Pennsylvanian tracks, both the larger and smaller, there is a protuberance like the rudiment of another toe. The average length of the hind foot is 5½ inches, and of the fore foot 4½. The fore and hind feet being in pairs follow each other very closely, there being an interval of about one inch only between them. Between each pair the distance is six to eight inches, and between the two parallel lines of tracks there is about the same distance. In the case of the English and German cheirotherium, the hind and fore feet occur also in pairs, but they form only one row, in consequence of the animal having put its feet to the ground nearly under the middle of its body, and the thumb-like toes are seen to turn to the right and to the left in the alternate pairs; while in the American tracks, which form two parallel rows, all the thumb-like toes in one set turn to the right, and in the other set to the left. Mr. Lyell infers, therefore, that the American cheirotherium belongs to a new genus of reptilian quadrupeds, wholly distinct from that which characterises the triassic strata of Europe; and such a generic diversity, he observes, might have been expected in reptilian fossils of such different ages. The geological position of the sandstone of Greensburg is perfectly clear, being situated in the midst of the Appalachian coal-field, having the main bed of coal, called the Pittsburg seam, a hundred feet above it worked in the neighbourhood, and several other seams of coal at lower levels. The impressions of lepidodendron, sigillaria, stigmaria, and other carboniferous plants, are found both above and below the level of the reptilian footsteps. Mr. Lyell then adverted to some spurious fossil foot-prints of dogs, hoofed quadrupeds, birds, and other creatures seen on the surface of ledges of a soft quartzose sandstone in the neighbourhood of Greensburg, which had been confounded with the fossil ones. He pointed out the proofs that these had been carved by the ancient inhabitants of America, whose graves are seen in the vicinity; and that the Indian hunters had sculptured similar bird-tracks, together with human foot-prints, in solid limestone of the State of Missouri,—the true origin of which was first explained by Mr. D. D. Owen, of Indiana.

To illustrate the mode of interpreting fossil foot-prints in geology, Mr. Lyell gave a sketch of the discovery of three distinct species of cheirotherium in Europe,—and explained how, after it had been conjectured by Link that they might belong to gigantic batrachians, Mr. Owen found, by examining the teeth and bones of reptiles of triassic age, that three different species of air-breathing reptiles of the batrachian order, referable to a new genus, labyrinthodon, had existed, both in Germany and England, at that period; their fossil bones indicating that they were air-breathers, and there being as great a disparity in size between the bones of their anterior and posterior extremities as between the fore and hind foot-prints of the several cheirotheria. To account for the sharpness of the casts of cheirotherium on the under surfaces of slabs of sandstone, Mr. Lyell adverted to the manner in which he had seen, on the sea-beach, near Savannah in Georgia, a cloud of fine sand drifted by the wind filling up the foot-prints of racoons and opossums, which, a few hours before, had passed along the shore after the retreat of the tide. Allusion was also made to the recent foot-prints of birds called sandpipers (*Tringa minuta*), which Mr. Lyell saw running, in 1842, over the red mud thrown down every tide along the borders of estuaries connected with the Bay of Fundy, in Nova Scotia. These consist both of impressions on the upper surfaces and of casts in relief on the under sides of successive layers of red mud (see Lyell's "Travels in North America," vol. ii. p. 166),—of which he has presented a specimen to the British Museum. The ancient foot-prints of more than thirty species of birds found fossil in the new red sandstone or trias of the valley of the Connecticut river, in Massachusetts, were stated to be analogous to these modern bird-tracks; and the size of the largest, although they indicate a biped more huge than the ostrich, is exceeded in magnitude by the gigantic deinornis of New Zealand—of which nearly the entire skeleton has just been found fossil by Mr. Walter Mantell. The absence hitherto of the bones of birds in the ancient American strata of the triassic period appears to Mr. Lyell quite intelligible; for the circumstances which combine to cause foot-prints of sandpipers in the recent mud of the Bay of Fundy, repeated throughout many superimposed layers, have no tendency to preserve any bones of the same birds,—and none have yet been ever observed in cutting trenches through the red mud, where it has been laid dry by artificial embankments and drained.

In all the cases of foot-prints, both fossil and recent, and whether made by quadrupeds or bipeds, the lecturer insisted on the necessity of assuming that the creatures were air-breathers, for their weight would not have been sufficient under water to have made impressions so deep and distinct. The same conclusion is borne out by the evidence derived from the casts of cracks produced in the same strata, by shrinkage, and so generally accompanying the impressions of feet; and it was remarked that similar effects of dessication are observable in the recent red mud of Nova Scotia, where thousands of acres are dried by the sun in summer, between the spring and neap tides. The ripple mark also so common in strata of every age, and among others in the coal measures, and new red sandstone of Germany, England, and America, exemplifies the accurate preservation of superficial markings of strata, often less prominent than those caused by the tread of reptiles or large birds. As the discovery of three species of cheirotheria was soon followed by the recognition of as many species of labyrinthodon, so the announcement by Dr. King, in 1844, of reptilian foot-prints in the coal strata of Pennsylvania, has been followed by the news lately received from Germany, that in the ancient coal measures of Saarbruck, near Treeves, the antiquity of which is vouched for by Von Dechen, Prof. Goldfuss has found the skeleton of a true saurian. Dr. Falconer, after a cursory examination of the original specimen, has stated his opinion in favour of its reptilian character, and although the evidence has not yet been rigourously tested by the most eminent comparative osteologists of Europe, Mr. Lyell believes that the opinion of Prof. Goldfuss and Dr. Falconer will be confirmed. Such facts should serve to put us on our guard against premature generalizations founded on mere negative evidence, and caution us not to assume the present limits of our knowledge of the time of the first appearance of any class of beings in a fossil state to be identical with the date of the first creation of such beings.

## PROCEEDINGS OF SCIENTIFIC SOCIETIES.

### INSTITUTION OF MECHANICAL ENGINEERS.

*Jan.* 26.—J. E. M'Connell, Esq., V.P., in the Chair.

The first annual general meeting of the members of this Institution took place at Birmingham, in the theatre of the Philosophical Institution, for the purpose of receiving the Report of the Council and for the general transaction of business. There were present nearly 100 members.

Mr. M'Connell said that as this was the anniversary of the establishment of the Institution, he would content himself with referring to the Report about to be read for the confirmation, he might say, of the more than realised hopes of the most sanguine promoters of the Institution. He was gratified to see so large a meeting, and regretted the unexpected absence of the President.

The Report of the Council was then read. It contained a brief outline of the proceedings of the Institution for the past year:—The desirableness and importance of founding a society such as this was known to have been long and extensively felt by the engineering and mechanical profession in all parts of the kingdom, and it is not too much to venture to say, that the best expectations of the active and zealous promoters of the Institution have been fully realised, and a great amount of scientific and valuable information has been beneficially and mutually interchanged and diffused amongst the members. In reviewing the matter and subjects brought under the notice and discussion of the members, as recorded and detailed in the minutes and proceedings of the Institution, the Council felt it their duty to acknowledge and particularise the following valuable aid:—the two papers on the "Fan-Blast," by Mr. Buckle; on a "Self-Acting Break," by the President; on an "Inverted Arch Bridge," by Mr. Cowper; on "Locomotive Engines," by Mr. Beyer; on a "Turn-Table Lathe," by Mr. A Slate; on "Jones's Gas Exhauster," by Mr. Clift; on a "Direct Action Steam Helve or Hammer," by Mr. H. Smith.

The following recommendation of the Council was then read:—

"The Council, having had under their consideration the question of the number of the members of the Council, have resolved to recommend to the members of the Institution to authorise the Council for the present year to add to their number, so as to place one member of Council, or more, as may be considered desirable, in each district where such may be advantageous to the interests of the Institution."

A resolution to the above effect having been proposed, was carried unanimously.

The officers for the ensuing year were then re-elected, viz.:—Mr. G. Stephenson, President; Mr. C. Beyer, J. E. M'Connell, and J. Miller, Vice-Presidents; Messrs. W. Buckle, E. A. Cowper, B. Fothergill, E. Humphreys, and A. Slate, Council; Mr. C. Gooch, Treasurer; Mr. A. Kintrea, Secretary.

After the conclusion of the business connected with the annual general meeting, the following papers were read:—

### HYDRAULIC LIFTING JACK.

"*Description of a New Hydraulic Lifting Jack.*" By Mr. Ald. Thornton.

The principle of this jack is the same as that of the hydraulic press, but not having been before applied to a lifting jack, it is thought that the present application of it will be useful for a variety of purposes. Its advantages are, the ease and steadiness with which a great weight can be raised by one person; the facility with which the lowering of the weight can be regulated without labour, and from there being no circular motion of the handle, there can be no tendency in the jack to twist from the position in which it is placed; also by the use of strong wrought-iron tubes for the cylinder and ram, the weight of the jack is less than others now known. This jack can be used in all cases where others are available, and in some where others are not so, for the motion of the lever being vertical instead of lateral, it can be used wherever there is sufficient width to place it. With a jack of the size shown one man can lift from 15 to 20 tons weight. Mr. Thornton said although the jack was not new in principle, one of its great advantages was to be found in the additional power which it gave to one man to raise so great a weight.

The Chairman said he presumed they all understood the description given by Mr. Thornton. The jack displayed itself by its own appearance and the drawing. So far as the trial he had had with it went, he had every reason to be satisfied. It was very simple, acted very nicely, and he thought it was a very ingenious improvement.

Mr. Crampton wished to know if it had ever tumbled down?

Mr. Middleton said all persons acquainted with such things must be fully aware that they could not get a jack boxed up. Until, however, an alteration could be made in the handle, it could not be considered a good thing practically.

Mr. Slate observed that though a jack might not be practically good when placed in a tumbling position, it might be good in other cases. A jack like the one now before them might be useful in lifting a great weight, where the ordinary one would not be sufficient.

Mr. **Buckle** thought that the jack was an exceedingly useful instrument. An ordinary jack would be much more liable to be put out of order than the one before them; besides, it presented greater facilities for lowering weights.

Mr. **Milner** was of opinion that as it was it could not be generally useful. If it was thrown from a tender to the ground it would be destroyed, and their endeavours should be to prevent it, if possible, from capsizing.

The **Chairman** said Mr. Thornton's object in introducing it was to have the benefit of their experience.

Mr. **Peacock** said, that for locomotive purposes it was not equal to Heeley's jack; still, if in other respects it possessed advantages over it, they ought not of course to condemn it.

In answer to other questions by various members, Mr. Thornton said it would lift 20 tons; it weighed about 65 lb.; and its price was 12 guineas.

Another member said he should give the preference to Heeley's jack. Lifting jacks when laid aside, like fire-engines in a country town, not being generally required, get out of order, and he was afraid that the one before them would be much more liable to injuries of that kind than the ordinary jack.

The **Chairman** said, it appeared that it was objected against the jack, that it was liable to get out of order, and that it had not the advantages of Heeley's jack in lifting from below, but from the top; at the same time it would be admitted that it was steady in action, and that in lowering weight it was necessary to have power and command, so as to do it slowly and easily. There was one important point in which it had not the advantage, and that was in price. In articles of that kind, the price was a consideration.

Mr. **Henderson** thought that the jack possessed advantages where there was a great weight to lift, and only one man to work it. Another advantage was the steadiness of its action. The great objection against it was its liability to get out of order. If they wanted a jack to raise 20 tons, he was not aware that they could get any other to do it with the same degree of steadiness.

## CYLINDER-BORING MACHINE.

"*On the Fitting-up of Cylinders for Locomotive Engines, and a Description of a Machine for Boring them.*" By Mr. C. **Beyer.**

The desirableness of having all the cylinders of every class of locomotive engines perfectly alike, so that they may, at any time, be changed in case of accident, or be replaced by spare ones, it is presumed will be admitted by all; the difficulty of accomplishing this with the tools hitherto employed, will be known to most who are engaged in this branch of the business. These considerations, and the defect of cylinders, the author, from time to time, found necessary to have rectified before passing them to be used, induced him, in 1843, to direct his attention to the boring-machine.

The conditions which a good cylinder boring-machine should fulfil, may be stated as follows:—1. That it should make the cylinder perfectly round in its diameter, and parallel in the direction of its axis. 2. That the bored inside should be perfectly concentive or parallel with the outside of the barrel. 3. That the projections beyond the flanches, if there be any, should be true with the internal bore. 4. That every strain or pressure upon the barrel of the cylinder whilst boring should be avoided. The boring-machine hereafter to be described has been found, during several years' practice, to have answered these conditions.

Messrs. Sharp, Brothers & Co. cast their cylinders from wood patterns in green sand, and commence the process of fitting-up by describing or gauging off a circle upon each end of the cylinder, concentive to the barrel, and having formed this circle the ends are bevelled inwards by chipping to an angle corresponding to that of the plates of the cone mandrill. The cylinder being fastened to the mandrill is put into a two-foot slide lathe, with facing motion, and has its ends faced to a gauge, and its projections turned to a gauge, and cut to a length to gauge. There are further two notches cut out of two cone discs, so as to allow of applying an internal gauge for the out-and-out length of the cylinder. Thus prepared by turning, it is removed to the boring-machine, inserted between two plates, the faces of which are planed, and the holes for receiving them bored from the boring-bar in their places; it is at once perfectly concentive with setting, and needs nothing but clamping to the plates by headed bolts or clamps by its flanches to be ready for commencing boring. For placing the tops of the steam-chests and valve facings the turned ends are again made use of for setting, by placing upon the planing-machine table brackets placed on their faces and bored out to the same gauge; the cylinder is turned to, in order to insure the parallelism of these parts with the axis, as for similar reasons the inside of the cylinder could not be otherwise than concentive with the outside of the barrel. The author prefers making a separate set of gauges, tackling, &c. for each size of cylinders rather than economise by making one do for many, and risk the chance of mistakes; and he believes that the plan here described, to work always from the same point, is most likely to insure accuracy, as the faults made by neglect of the workmen are not multiplied by subsequent operations.

The boring-machine bores by two cylinders at the same time, and is arranged to bore cylinders of 2′ 6″ strokes and from 10 to 20 inches diameter. The bed is that of a common slide lathe, sufficiently long to carry a double set of driving gear, and admits of a sufficient traverse of the boring-carriage. The boring-bar is supported by three bearings, the former of which is stationary and firmly fastened to the bed to resist the end and pressure of the cub when boring; the latter are fixed upon the carriage and travel with it along the boring-bar, and serve for securing the cylinder during boring, as will be shown hereafter. To cause the boring-carriage to move endways, a train of wheels descends at the back of the machine to give motion to the shaft, and is transferred by means of a feathered worm to the worm-wheel and pinion, both of which move loose above the fast stud of the carriage. This same stud serves as a fulcrum for the lever, carrying upon opposite projections the intermediate pinions, which gear into the stud pinions. It will be clear, therefore, that by setting the lever in such a position as to bring one pinion into gear with another pinion fast on the rack-pinion shaft, motion will be given to the boring carriage in one direction; and in an opposite or contrary direction by moving the lever so as to bring the pinions to gear with each other; and this carriage will be stationary or independent of the driving gear altogether, by keeping the lever in its middle position. The rack pinion shaft is extended towards the front of the machine, to work the carriage by hand when putting in or taking out the cylinder. A provision is also made in the train of wheels for varying the traverse of the carriage by changing the pinion.

To hold the cylinder while boring, the top of the carriage is formed into a kind of square frame, by means of two plates, planed on the inside and fastened to the sides of the bearings or standards and two cross stretchers. These latter are also placed upon their inner faces and are secured to the sides and top of the boring-carriage, and have holes bored in them when secured in their places, by means of the boring head upon the bar corresponding in diameter to the turned projecting ends of the cylinder to be bored. It will be seen, therefore, that if the figure of the cylinder to be bored be turned to the same gauges as the holes are bored to, it needs only inserting and clamping fast by the T bolts to be ready for boring without requiring any setting in its pan whatever. One of the cross stretchers is a fixture, whilst the other is removed every time a new cylinder is to be fixed. The boring head is a fixture upon the bar, and has only one plain square tire for boring, ground to cut either way. This tool fits into a planed recess made slightly dovetailed, and is held fast by a set screw, and easily adjustable to any diameter by another of these machines. We employ three of these machines—two double ones and a single one, and one man attends to these and the lathe for facing and turning the ends of the rough castings of the cylinders. The cylinders are cast as hard as we are able to cut them with the best cutting tools we can make, and we find it more advisable to complete the boring in three cuts; the first is often as much as $\frac{3}{4}$ inch in depth, the second we leave about $\frac{1}{8}$ inch, and the third can hardly be called cutting, but is merely clearing up or finishing. The advance, or traverse, we rarely change, and is set to $\frac{1}{4}$ of an inch for each revolution of the boring-bar; or is, for quickest speed of the bar, 3 revolutions per minute; in the second, 1·8 revolution per minute; in the third, or lowest speed, 1·2 revolution per minute. For boring 15 inch cylinders—for roughing out, 1·8 revolution per minute, or cut at 7 feet per minute; for boring, 3 revolutions per minute, or cut at 11·78 feet per minute; and for finishing, 1·2 revolution per minute, or cut at 5·65 feet per minute.

Mr. **Crampton** said they should be doing very great injustice to the very valuable paper they had heard read were they to discuss it at that late hour, and he should propose that the further consideration of it should be adjourned till the next meeting. The suggestion was adopted and the meeting terminated.

## JACQUARD PERFORATING MACHINE.

"*Description of a Perforating Machine,*" made for Mr. Evans, the contractor for the iron tubular bridge which is to carry the Chester and Holyhead Railway over the river Conway. By Mr. **Fothergill.**

This machine is employed to perforate the plates for the above-named bridge, and is at present adapted to punch such pitches only as that work requires, viz., 3 inches and 4 inches from centre to centre of rivet holes, with latitude for departing considerably from those (general) pitches in the lateral rows of the holes. This machine is constructed to perforate, at each stroke, a row of holes across a plate 3 ft. 5 in. broad; but, by employing a series of card plates (similar to the cards used in the Jacquard loom), any number of punches may be put out of action at pleasure; and by means of a blank card at the end of the series, the machine is put out of action at a point where no obstacle is presented to the taking out of the perforated plate and putting a blank plate in its stead. The operation of changing plates, weighing six or seven hundredweight each, is performed by half a dozen men in less than one minute, and whilst one plate is being punched, these men get another ready to put into the machine. As these machines take eleven to twelve strokes per minute, it follows that (with a 4-inch pitch) a 12 feet plate may be punched in less than four minutes, and consequently that (allowing one minute for changing) it may perforate twelve such plates per hour. Many of the plates in the bridge are 12 feet long, 2 ft. 8 in. broad, and $\frac{3}{4}$ inch thick, and are punched for rivets 1 inch in diameter. As there are but few engineering concerns where such a perforating machine as that at Conway could be employed more than an hour or two per day, it appears to be very desirable that ironmasters should have them, and that they should also have machines for straightening and bending plates; by which means they would be enabled to supply their customers with plates in a fit state for being rivetted together. Were this system brought into practice, engineers would turn their attention to adapt their work to the capabilities of the perforating machine, and thus great perfection, dispatch, and economy of construction would be the result. A drawing represented a machine (similar in principle to that already described) adapted to perforating paper and thin sheet metal, such as sieves and window-blinds are made of, in which plain perforations, arranged in squares, may be made by a single row of punches; and perforations, arranged quincuncially, may also be made by a single row of punches, by giving to the plate a lateral alternating motion; but a double row of punches, arranged intermediately to each other, is preferable. Each of these arrangements admits of a great variety of fancy patterns by the application of the Jacquard principle. A large class of patterns may be produced by punches of various forms and sizes, which shall be so grouped together as to give to the work a columnar effect; and the range of this class may be extended by giving the plate a zig-zag or waved motion, and still further extended by combining it with the Jacquard. Another class of patterns may be produced by employing two distinct sets of punches of different size or form, and with each set a Jacquard, to bring punches of the one or other set into action as required, and thus be made to produce representations of figures, landscapes, &c., at pleasure. A further variety of patterns might be produced by the introduction at intervals of punches containing set patterns, such as sprigs, flowers, &c., and perforating the ground with small punches.

The foregoing is but a brief description of the capabilities of the Jacquard Perforating Machine, which in good hands would be found to be nearly co-extensive with those of the Jacquard loom. Another drawing represented a double-acting machine for shearing (at the one side) and punching (on the other), at the same time, plates of iron ¾ inch in thickness with holes 1½ in. in diameter, and to perform both processes to the extent of 18 inches from the edge of the plate.

The Chairman said it was a machine represented as peculiarly adapted for perforating plates used in ship steam-boilers, girders, &c. But, from the description, it appeared to him to be a very useful machine for steam-boilers generally. Seeing the great accuracy with which the punch is made, it would be rather interesting to follow out the applicability of the machine.

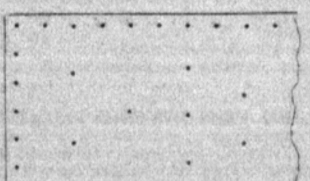
Mr. Ald. Thornton asked if the machine punched in any other than a straight direction?—Mr. Fothergill said it did, and it would punch twelve holes at once.

Mr. Beyer thought it was a very excellent punching machine, and it might be applied to a great extent, and to all ordinary-sized boilers.

In answer to questions by various members, Mr. Fothergill said, all the punches acted upon the plate at the same time.

In order to give an idea of the nature of the work to be performed by this machine, we subjoin the annexed diagram and description, taken from the *Manchester Guardian*:—

"The diagram represents a portion of a wrought-iron plate, which we will assume to be, when entire, 12 feet long by 2 feet wide, and ¾ inch in thickness, and requiring to be perforated, along each sides and ends, by a row of holes *exactly* four inches asunder from centre to centre, and each an inch in diameter; as well as by certain intermediate holes of the same size, the situation of which will be best understood from the diagrams.



"On looking to the left hand of the diagram representing the entire end of the plate, it will be seen that there is vertically a row of seven dots, representing seven perforations or rivet-holes. These perforations the machine makes at one moment, by bringing down with immense force seven punches of tempered steel, upon that part of the plate which at the time rests upon the same number of dies, also of tempered steel. These perforations being made, the punches are lifted clear of the plate, which is then moved forward longitudinally, exactly four inches; and then the striking peculiarity of the machine comes into play.

"It will be seen on looking carefully at the diagram, that the second row vertically of perforations, counting from left to right, instead of seven contains only two, one at the upper and the other at the lower margin, each forming a part of the two side rows of rivet-holes. These two holes the machine perforates also at one blow; but as there are seven punches, and only two are required, the five intermediate ones are thrown out of use by a contrivance exactly similar in principle to that of the Jacquard loom, by which figures are produced in silks and other fabrics. The third vertical row of holes, still continuing from the left, consists of four, the fourth again of two, the fifth of three, and so on, the number varying through the whole length of the plate; and, in each case, the machine itself, without the slightest interference of the workman, moves the plate on to the required distance, selects the proper number and right situation of the punches, makes the requisite number of perforations, and throws itself out of action when the plate is completed. Those who are aware of the force necessary to perforate an iron plate of moderate thickness, even with a single punch of small size, may form some judgment of the enormous power required to impel seven punches, each an inch in diameter, through plates three-quarters of an inch thick; and it is a little singular to see this enormous power regulated in its operation by the identical means employed in producing figures in the most delicate fabrics. The machine is calculated to make, when necessary, *twelve* perforations by one stroke, and to produce any requisite combination of twelve or any smaller number of punches, at distances of three or four inches from each other. The speed with which the work is performed may be understood from the fact, that it regularly completes the perforation of one plate of the size above described,—namely, 12 feet long and 2 ft. 4 in. wide,—in four minutes; and if the plates were so quickly supplied as to prevent any loss of time, which might easily be done, it would complete them regularly at that rate. As it is, fifty have been completed in four hours. But the facility and dispatch resulting from the use of the machine are not, perhaps, its greatest merits, so far at least as the construction of tubular bridges and beams are concerned. In such cases, the strength of the fabric depends in a great degree upon the whole of the rivets completely filling the perforations, retaining a regular cylindrical form, continuing perfectly straight, and being, throughout their length, exactly at right angles with the faces of the plates. As each of the perforations represented in the diagram is intended to correspond with a similar perforation, either in another plate, or in an angle or T iron, it must be obvious that deviations in opposite directions of a sixteenth of an inch in each, would prevent them fitting each other by an eighth of an inch altogether; and, whatever might be done by enlarging one or both of the holes, to bring them a little nearer each other, the firmness and strength of the work must be impaired by he direction of the rivet being rendered in some degree oblique, instead of being exactly at right angles with the plate; whilst, in the work performed by the machine, the perforations are set out with such accuracy that they always correspond precisely, and the rivets retain their proper form and direction."

*The Dinner.*—In the evening the members and friends, amounting to about 100, dined together at the Queen's Hotel—Mr. M'Connell presiding.

## ROYAL INSTITUTE OF BRITISH ARCHITECTS.

*Jan.* 24.—Mr. Charles Fowler, V.P., in the Chair.

The donations included a number of works by the celebrated archæologist, M. de Caumont, of Caen, a corresponding member of the Institute. Mr. Wallen sent a portion of the mosaic pavement found nine feet below the present level, while digging the foundations for the new warehouses of Messrs. Morley, at the corner of Gresham-street and Wood-street. Mr. Wallen thought a Roman temple formerly stood on the spot.

Professor Donaldson read a paper on "*Caen, its Quarries and Buildings, with a few words on Arras.*" This paper we have given in full in another part of the *Journal.*

Some very high compliments were paid to Mr. Donaldson on this valuable paper.

*Feb.* 7.—Mr. Angell, V.P., in the Chair.

Among the donations reported were Canina's work on Etruria, sent in the name of the Queen of Tuscany; Mr. Sharpe's "Architectural Parallels;" and eleven volumes of the "Bau Zeitung," the architectural journal of Vienna, edited by Mr. Forster; and parts of Billings' "Antiquities of Scotland."

Mr. Wright sent a set of drawings illustrative of the ceiling at Carpenters' Hall, London-wall.

Mr. G. L. Taylor read a paper in reference to the New Western Gas Company, entitled "*Some observations on Gas-works, and the details of the Manufacture of Gas; with the view of showing that it is capable of being rendered so Pure as to be introduced beneficially throughout Houses, Manufactories, and Public Buildings,*"

Mr. Burn observed that formerly he resided at Edinburgh; that he had twice as many burners as he now has in London, and paid at a much higher rate, being 9*s.* per 1,000 cubic feet. The gross charge at Edinburgh was however only one-half of the London gross charge, arising from the superior illuminating qualities of the Edinburgh gas. It is true, the latter is made from Cannel coal; but there is an unfortunate temptation to gas companies to deteriorate the quality of gas, in consequence of the charge being made on the quantity. He further observed, that though the Edinburgh gas is superior in illuminating power, it is not free from impurities; in proof of which he said all the book-binding and leather furniture of a new club-house at Edinburgh had been destroyed by the gas, as the book-binding of the Athenæum club-house, in London, has likewise been injured.

Mr. Palmer dwelt upon the importance of the purification of gas, and said that the new plan showed its practicability.

The Western Gas Company have their works in a building at Kensal-green, 166 feet in diameter. They propose to use Cannel coal, and supply gas at 6*s.* per thousand feet, which they say is as cheap as common gas at 4*s.* per thousand.

## INSTITUTION OF CIVIL ENGINEERS.

*Feb.* 1.—Joshua Field, Esq., President, in the Chair.

The President, in taking the Chair for the first time since his election, addressed the members at considerable length, dwelling chiefly on the intimate connection between the civil and mechanical engineers, their dependence upon each other, and the importance of maintaining that union between the two branches of the profession that had ever been one of the main objects of the Institution. He showed, that originally engineering was confined to the constructive or mechanical branches; raising heavy weights, building mills, draining mines, and all the primitive wants of mankind; by degrees, as civilisation extended, the exigencies of the world became greater; luxuries were required, that could only be supplied by greater exercise of talent and skill; manufactories were multiplied, manual labour could no longer suffice, the steam-engine was generally employed, and the consequence of this increase of production was, that the roads required to be amended, rivers and canals to be cut, for carrying this abundance of merchandise and passengers, whilst docks and harbours required extending, for the reception of the shipping for the increasing export trade. These wants called into being another class of men, who, with great mechanical skill, combined more than ordinary theoretical knowledge and business habits, to enable them to combine and use the powers of all other classes. These men were termed civil engineers, in contradistinction to military engineers, whose education and experience fitted them solely for the art of war; and by these men, Great Britain had been placed first in the list of the civilizers of mankind. Mr. Field, as the first president elected from among the mechanical engineers, dilated, at length, upon the immense strides made within the last century in the production of the mechanic arts and in public works, under the combined efforts of the two classes alluded to. He then entered more minutely upon the subject of steam navigation, to which he had principally devoted his personal attention, and gave most interesting details of the subject, ending by apologising for occupying so much of the time of the meeting by saying, that he must be permitted to feel more than ordinary pride in being elected the president, when he looked around him, and saw that the association of six young engineers, who, in 1818, met occasionally to chat over mechanical subjects, had extended, in the course of twenty-nine years, into a society consisting of upwards of 600 members, and comprising within it almost all the engineers of eminence in Great Britain.—The address was vehemently applauded, and the president was requested to allow it to be printed in the minutes of proceedings.

The discussion was then renewed upon Mr. Ransome's paper, "*On the Manufacture of Artificial Stone.*"

The Dean of Westminster, Sir Henry De la Beche, Mr. John Phillips, Dr. Garrod, Mr. Barry, and other visitors, took part in the discussion with the principal members of the Institution. The remarks turned chiefly upon the chemical and physical properties of the material, and the cost of its production in the moulded form as compared to that of carved stone. In its chemical properties it was shown to be at least equal in purity to the production of Nature; for, on the statements of the eminent chemists who had subjected it to severe tests, it was proved to be totally insoluble in boiling water, however long immersed, and also to be capable of resisting the action of mineral acids. In this respect it differed from glass, which always yielded a portion of its alkali to the action of water. It was further stated, that it had perfectly resisted the action of frost, vases filled with water having been repeatedly frozen without their sustaining any injury. Satisfactory statements were adduced as to its strength and other physical properties, and some very interesting remarks were made on the subject, comparing the substance produced artificially with certain sandstones found in this country, which, by the action of compression and heat, had attained a degree of hardness equal to quartz. The experiments of Hall and Watt on the production of artificial stones were also alluded to as bearing upon the question. Experiments made on the strength of the artificial stone proved it to be superior to those natural stones with which it had been tested—viz.: Caen, Bath, York, or Portland stone. Numerous specimens were exhibited to the meeting, showing its universal applicability to constructive and decorative purposes; fractured pieces were shown of every variety of texture, from the porous sandstone to the most compact granite. The price of the material was stated to be such as to render it available for all useful and ornamental purposes.

*Feb.* 8.—Joshua Field, Esq., President, in the Chair.

The paper read was "*An account of the recent Improvements in the Drainage and Sewage of Bristol.*" By Mr. James Green.

From this account it appears, that for many years past, great reformation had been requisite in the sewage of several parts of the city of Bristol, and more especially in the localities adjacent to the course of the River Froome, whose channel had become a large cesspool, spreading miasma and disease all around. This river formerly emptied itself into the River Avon, in the city; and then all that was brought down by the stream was carried away by the tide; but, when to form the floating harbour, the old course of the Avon was dammed across by lock-gates, and a new cut was made for carrying off the contents of the sewers emptying themselves into the Froome, a nuisance of the most serious character was created, and the bed of the river became permanently affected. Mr. Mylne, some years since, constructed a lateral culvert from the *embouchure* of the Froome, *debouching* in the new cut; this did partial good; but still the general state of the river remained unimproved; and, in deference to the universal demand for sanitary reform, the authorities of Bristol employed Mr. Green to devise and execute plans for the improvement of the sewage of the part of the city most demanding it. He laid out comprehensive plans, but the estimate of their cost exceeded the funds at the disposal of the council; so he modified them, and the result had proved most successful. The proceedings were to bring the channel of the river into an uniform width, by building side walls, with gutters in the upper slopes, conveying the sewage into the stream, obliterating the shoal, and cleaning up the bed, thus bringing it to an uniform inclination; removing the obstructions caused by the pier of the Castle Mill-street-bridge; lowering the height, and extending the length of the Wear at the castle moat, with new flood-gates, &c.; deepening the bed of the upper part of the stream, and thus making convenient arrangements for cleaning out and flushing the channel, and passing off the products through Mylne's culvert into the new cut, whence it was conveyed away by the tide. The Dock company's culvert was also cleansed and repaired at the same time, and brought again into operation. Many difficulties attended these proceedings, but they were skilfully combated, and the result has been most complete success; and it is to be hoped, that the further ameliorations of which the general sewage of the city is susceptible, may be equally successful under the control of Mr. Green, who has so ably conducted them upon a modified scale. For, as the actual expenditure was not more than £4,537, as stated in the paper, and such beneficial effects have been obtained, there can be no reason why any proper measure of sanitary reform should not be carried into effect.

In the discussion which ensued, several very able men took part, bearing testimony to the satisfactory nature of the improvements made by Mr. Green at Bristol. The conversation then turned upon the employment of the contents of sewers for agricultural purposes. The system proposed by the various companies were detailed and canvassed. The lands which had been rendered fertile by the application of liquid manure, near Edinburgh, and near Mansfield, were quoted as examples of the efficacy of the system; but, on the other hand, it was shown that these were not fair examples, as the localities were peculiar; the cost of the establishing was much larger than could usually be borne; and that, in general, if the distribution of the contents of the sewers was to be made by pipes and pumping, the returns would never repay the outlay.

*Feb.* 15.—The discussion upon Mr. Green's paper, was renewed, and continued throughout the evening, to the exclusion of all other business. The main object of the paper appeared, unfortunately, to be lost sight of by the speakers, in their anxiety to bring forward, or to defend, the positions assumed by various companies, which had been formed at different periods for using the products of the sewers for agricultural purposes, but which, in the former part of the discussion, had been somewhat impugned upon commercial grounds. The statements made at this meeting were only repetitions of what has been repeatedly printed in reports, and in evidence before the sanitary commissions; and the whole evening may have been said to have been wasted, in spite of the attempts of some of the members to bring the discussion to the real question of the best modes of laying out a system of sewage for large towns, the forms of the sewers, based upon the laws governing the conveyance of fluids—which, it had been stated in some of the "blue books," were not understood by civil engineers, a statement which was shown by some of the speakers to be not consonant with facts; for that, if the selected, rather than collected, evidence given before the Health of Towns Commission were analysed, it would be seen that the exploded dogmas of the older writers on hydraulics had been received and adopted, rather than the formulæ of modern writers, or the actual practice of civil engineers of eminence, whose experience on such subjects was necessarily great. It was true, that hitherto, in consequence of the absorbing topic of railways, eminent engineers had not devoted themselves to the subject of sewage to the extent they might have done; but, when the time arrived for their doing so advantageously, or the exercise of their skill was demanded by the government, or by private enterprise, they would be found quite prepared to devote themselves to the work.

## SOCIETY OF ARTS, LONDON.

*Jan.* 19.—William Fothergill Cooke, Esq., in the Chair

The Secretary read a paper by Dr. Harding, "*On some ancient Greek Vases, excavated by him from Tombs near Hexamili, in the Isthmus of Corinth.*"

"In the autumn of 1840, having obtained by private influence, an order from the prime minister, permitting me to excavate for antiquities, I proceeded (observes Dr. Harding) to Corinth, and hearing that the peasants frequently found ancient tombs, containing vases, under the village of Hexamili, I proceeded thither with a party of labourers. Hexamili lies between Corinth and its ancient port of Chincre, within three miles of the spot where the Isthmian games were celebrated. The ground about Hexamili is, for the most part, rudely cultivated, and grows good crops of wheat; ancient quarries also abound. The plan adopted in searching for tombs is that of boring the ground with augers, seven feet long, till the instrument meets with some obstacle to its further progress, when it is withdrawn, and the ground is again pierced in other directions, to ascertain the size and nature of the obstruction; this is also tested by the sound of the instrument striking against it. When a tomb is discovered, and this is generally at a depth of about four feet, the earth is excavated in the usual manner in which graves are dug in England; and as soon as sufficient of the covering of the tomb is exposed, a man sits down with a heavy hammer (such as is used by masons), and with this a hole is made in the lid or covering to the tomb. A hand is then carefully inserted, and human bones, vases, &c., are generally extracted. The greatest number of vases I found in any one tomb was fourteen, and children's tombs had proportionally small vases. Having in three days collected enough to load one of the small horses of the country, I got them to Corinth, whence they were sent to Athens, and afterwards by sea, *via* Malta, to London."

Mr. **Birch**, of the British Museum, was in attendance, and stated that he was unable to give any account of the chemical constituents of the vases, or the particular manner of their fabrication; still he should be glad to offer a few remarks in reference to the specimens exhibited. It is only of late years (he observed) that the conclusion had been come to that large manufactories of vases existed in Greece; they had always been supposed to be of Etruscan produce. The fictile art had been supposed to be confined almost exclusively to Italy, although numerous excavations had been made at Athens, and a few at Corinth, which had produced specimens similar to those exhibited, and which he divided into classes. The most ancient vases (and which are distinguished from all others by the material of which they are composed) are of a light yellow clay, and have figures and animals painted on them in a maroon colour. Their date is supposed to be about 616 years before Christ. About this period the fictile art is reported to have been introduced among the Etruscans by the Greeks. The second class of vases are of a pale red clay, and the figures, instead of being of a maroon colour, are traced in black, in order to show the details more distinctly. This style appears to date from the fifth to the middle of the fourth century before Christ. The third class is one in which the colour was laid on by means of a reed. But perhaps the highest style, and one which is peculiar to the vases found at Athens, is that in which the outline, &c., is traced in white paint, or a sort of carbonate of lime. The vases exhibited he thought peculiarly interesting, as deciding that the vases of Italy may be considered to be the manufacture of Greeks settled in Italy, and not imported from Greece into that country.

Dr. **Harding** stated that the tombs at Hexamili seem to have been scattered in irregular patches; but the cemetery appears to have been very extensive, measuring nearly half a mile in each direction. No inscriptions or marks whatever are visible on the stones of the tombs, nor is there any other apparent difference externally than that of size. The bones in them were tolerably perfect, and the skulls nearly entire. He found but one piece of metal, apparently part of a large bronze needle or bodkin. Generally, the contents of the tombs were in a wonderful state of preservation, considering that they were, in all probability, at least 2,000 years old.

### *Jan.* 26.—George Moore, Esq., F.R.S., in the Chair.

The Secretary read a letter from Mr. **Dwyer**, in which he states, as the Society is to meet for the purpose of investigating the forms of *Ancient Pottery*, he begged to present for its acceptance a series of sketches, believing that they might prove of some utility in assisting its researches. He says that having observed that ancient art generally originates through the imitation of natural objects, he was led to infer as highly probable that the beautiful outlines of the Grecian vases emanated from similar sources; and proceeded to point out the exquisite forms of leaves and fruits, suggesting the probable manner in which they had been used to give character and beauty of outline to those manufactures.

The second communication was from Mr. W. T. **Griffiths**, and accompanied a copy of his work "*On the Natural System of Architecture.*"

The communication alluded to the work as pointing out the geometrical proportions of the temples of Greece, and calling attention to the applicability of geometrical design to domestic architecture, and as also affording a ready means of obtaining beautiful patterns for oil cloths, carpets, &c. The author then proceeded to point out the improbability of the ancient Greek vases being constructed on any other than pure geometrical principles, as is proved by analysis; and concluded by alluding to the mistaken but very prevalent notion that to produce a beautiful building, it is necessary to overload it with meretricious ornament,—instead of feeling that the more simple is often the more beautiful design.

Mr. **Varley** made some remarks in reference to Mr. Dwyer's communication, and stated that although we have many artists of highly-cultivated taste, still they have not the necessary knowledge to enable them to produce good art. In reference to a leaf having given rise to the forms of the Greek vases, he would observe that a leaf in itself is a pendant body, and as such is very beautiful: but no single leaf would stand upright. We might take some pendant fruits, such as the apple,—which might be said to have a base, and some vases might be compared to it; but he did not think that they gave rise to the forms of the Greek vases, although he must admit that Nature was the first teacher of everything that is beautiful. There are certain rules, Mr. Varley said, which Nature suggests, and which we find the Greeks used; and he proceeded to point out the following method which might be used for producing agreeable forms, such as the bodies of the vases exhibited—viz., by taking one-quarter of an hyperbola, parabola, or ellipse, according to the outline desired; and by rotating it on its axis at any given angle, it would be made to produce the figure desired. Similar simple methods for obtaining the necks and stands for vases were also described.

The **Secretary** made some remarks on the forms of vases, and stated that if beauty consisted in the imitation of Nature, as suggested by Mr. Dwyer, a man would have nothing to do but to take the first leaf of a tree as soon as he came to it; instead of which, discontented with the first fifty leaves, he goes on seeking and seeking, till at last he finds one which pleases him, because it comes up to the ideas in his own mind, and which he had preconceived as the standard of beauty.

Mr. **Wyndham Harding** considered that the effect of vases and other domestic utensils, as well as the architecture of everyday life, should produce on the eye an effect equally pleasing with music on the ear; and that, as in order to obtain harmony in music it is necessary that the cords or wires should each vibrate a proportionate number of times, so should the proportions of one part of a vase bear a given relation to those of another. In relation to architecture, several persons have considered that certain numerical simple proportions can be traced as existing in the various members of ancient Greek temples, and Mr. Donaldson had stated that he has revived the means of determining the precise proportion of various parts of all Gothic buildings: and these geometric and harmonic relations must have been known to the Greeks in the formation of their works.

Mr. **Smith** stated that he did not consider that geometry was used by the ancients to the extent which is generally attributed to them, but rather that their works were the result of a practised eye and hand, guided by a highly-cultivated taste.

### *Feb.* 9.—Baron Goldsmid, V.P., in the Chair.

The Secretary introduced the business of the evening by some remarks on "*Polygonar Decorations,*" as follows.

The discussion on the construction of ancient Greek vases, which had lately occupied the meetings of the Society, had occasioned several treatises to be written and a great amount of attention to be paid to the subject. It is continually alleged as a fault of the art in our day, that instead of boldly creating forms and trusting to our own minds, and carrying out those feelings according to what we consider the enlightened principles which we have struck out for ourselves, we are contented to take for granted that the ancients were artists truly unapproachable, and such we can never hope to equal, much less to excel; and, therefore, the best thing that we can do is to abandon altogether originality, and give ourselves up to the study and copying of the antique forms. The Secretary then pointed out the effect of a design upon the mind and senses in the case of polygonar art, and called attention to the effect of such a combination of colours and forms as shall produce upon the mind the effect of a design standing out from the wall or pavement, but which, if felt by the hand or foot, is perfectly flat. He next proceeded to point out the forms of the tesseræ and geometric figures which had hitherto been used in combination to produce design, and pointed out the beauty and variety of design whioh might be obtained by the combination of a form of tessera, which, although not new, had not up to this time been used as the base of a pattern. The figure which was pointed out as most applicable to mosaic decorations was the triangle of Plato, any number of which might be arranged round a point and made to cover an entire surface, forming bands either horizontally, diagonally, or any variety of diamond figures, as the sides of the triangle bear a peculiar ratio, namely, 30, 60, and 90 degrees; whereas, where figures of inharmonious ratios are used, the same variety cannot be obtained.

Having thus pointed out the applicability of geometric figures to the production of beautiful forms, the Secretary gave several extracts from a paper on the "Beau Ideal Head," by Mr. D. R. Hay; from Mr. Blashfield's paper on the "Construction of Fictile Vases;" Dr. Wampen's communication on the "Geometrical Proportions of the Human Figure;" and Mr. Digby Wyatt's paper on "Ancient Tesseræ;" also a letter from Mr. J. Jopling, as to the improbability of ancient vases having been construoted on any other than purely geometrical principles.

Dr. **Harding** made some remarks as to the uses to which the various cups and vases excavated by him had been applied, and gave the following quotation from an ancient Greek play, as illustrating the purpose to which the Lecythé had been applied. The play is one in which a young man is represented as jeering an abandoned old woman, and is saying—

> "But you old wretch, I greatly dread your lover."
> "Who?"
> "Why, that first of artists."
> "Who is that?"
> "He who for dead men paints the Lecythé."

Another quotation as pointing out the use of these vessels, is as follows:—

> "You left me like a corpse laid out; only uncrowned and with no Lecythés on me."

After alluding to the probable purposes to which the several other specimens of vases were applied, Mr. Harding stated that what had been said by Mr. Birch at a former meeting (as to the manufacture of vases having been introduced into Italy by Eucheir and Eugrammus, artists who had fled from Greece), was a myth, and could not be received. Corinth, he observed, has been celebrated at all times, according to Strabo, for its politicians and for the promotion of the useful arts, both graphic and plastic, and for every species of useful application of them; also for some beautiful, but not numerous, specimens of objects connected with sepulchral rites.

## ROYAL SCOTTISH SOCIETY OF ARTS.

### *Jan.* 24.—George Buchanan, Esq., F.R.S.E., President, in the Chair.

The following communications were made:—

1. *Description of a Marine Hydrometer, adapted for ascertaining the comparative Saltness and Freshness of Sea and River Waters.* By George Buchanan, Esq., President.

This is an instrument which Mr. Buchanan stated he had found extremely useful in inquiries connected with the prevalence of sea and river water in different estuaries, and therefore he thought a short notice of it might not be uninteresting to the Society. In the great question connected with the salmon fisheries in regard to the respective limits of the river and the sea, the prevalence of fresh or salt water had been considered an important element; but finding the usual methods of measuring the specific gravity by weighing the waters in a delicate balance, not very applicable where numerous specimens were required to be tried on the spot, it occurred to him that something on the principle of the hydrometer might be used, and this was the instrument which was exhibited, consisting of the bulb of a spirit hydrometer, loaded so as just to sink the bulb in salt water, and having a long stem attached, which, in fresh water, becomes almost wholly immersed. Some difficulty was found at first in adapting the scale, as it must not only be thin but light, otherwise it tends to overbalance the instrument. A slip of whalebone or ivory answers sufficiently well, and several instruments were shown of this description, and one entirely of brass. The use of the instrument was clearly exhibited in several experiments with fresh water, and with the waters of the Forth, some from Granton Pier, some from Queensferry, and some from Alloa. From Granton Pier the water, even at low tide, has a very little impregnation of fresh, as compared with the German Ocean, which he had found, along the eastern shores of Scotland, seldom to exceed the specific gravity of 1026, fresh water being 1000. At Granton Pier the average of high and low water was found 1024½, or about one part fresh in sixteen salt. At Queensferry it was found 1023, or about one part fresh in eight salt. At Alloa the waters at low tide are almost quite fresh; and at high water the specific gravity was found nearly 1012, or nearly half fresh, half salt. A considerable difference is found between the surface and bottom waters. The specific gravities of different seas were then stated. The Arctic ocean 1027; the waters under the equator 1028; and the Mediterranean, which is nearly the saltest of any sea, 1029. But the heaviest of all waters are those of the Dead Sea, which are strongly impregnated with sulphurous and bituminous ingredients, as well as with salt, and have been found about eight times heavier than sea water as compared with fresh, having the extraordinary gravity of 1211. By the use of this simple instrument, many interesting observations might be made by voyagers in different seas.

2. *Description and Drawing of a Glass-Blowing Apparatus, being a new invention in the Blowing of Glass.* By Mr. William Cooper.

This invention consists in effecting the blowing of glass by means of double bellows placed under the floor, acted on by the foot of the glass-blower, and the air is carried to the blow-tube by means of a flexible tube, easily attached and detached from the nozzle of the ordinary iron tube. The advantages are stated to be, that larger articles can be blown, that the glass is freer from "cockle," and that the lungs of the workman are saved, and his muscular energies not being so severely taxed, he will be able to produce a great deal more manufactured goods in a given time. The air blown by the bellows being of a much purer quality than that from the lungs, produces a better article. That larger sizes and a thicker substance of blown plate may be obtained by this new process, and the sheet-glass manufacturer will be able to compete with the cast plate-glass monopolist. That "carboys" to contain twelve and sixteen gallons have been successfully blown by this process. Mr. Cooper then recommended that this process should be adopted in Edinburgh and Leith, where coal is cheaper than in Staffordshire by 4*s.* per ton, and where living and house-rent are about one-fourth less; the workmen all preferring Leith, from its healthy situation, cheapness, and family conveniences. Locality, he stated, is now looked at; economy in carriage is itself a profit to the manufacturer, now that the duties are removed, and all the English manufacturers circumscribing their connection.

3. *Description of an Elevator, for raising Building materials or other bodies,—and capable of being used as a Fire-Escape—containing a new application of the Pulley.* By Mr. Robert Davidson, Engineer.

Mr. Davidson stated that this machine or elevator was applicable as a fire-escape, and well suited to the raising of small weights to great heights, such as in mills and factories; or in the raising of scaffolding for workmen, such as painters, plasterers, masons, &c. It consists of a number of sliders, moving within each other by means of a fixed pulley attached to the top of a fixed upright, which is hollow, containing all the other sliders, which are hollow also, except the last one, which may be solid, the top of which contains a platform enclosed by a railing. There is a chain or rope fastened to a hook in the bottom of the top slides, passing over a moveable pulley, made fast to the top of the next slide, and passing down the outside of it and made fast to the top of the next slide following, on the top of which is also a moveable pulley, over which passes a rope or chain made fast to a hook in the bottom of the slide immediately preceding, the other end of which is made fast to the top of the fixed hollow upright, on the top of which is placed a fixed pulley, which guides the chain whereto the power is applied; the one end being made fast to a crane barrel, and the other end attached to the bottom of the slide next adjoining, which compels a simultaneous movement of the whole machine.

## NEW PALACE OF WESTMINSTER.

Return (*dated December* 20, 1847) *of the Aggregate Amount already paid, or agreed to be paid, to Contractors and other Persons for the Purchase of Land and Houses for the Erection of the Palace of Westminster* (*or Houses of Parliament*).

| | £ | s. | d. |
|---|---|---|---|
| 1. The cost of the purchase of the lands and hereditament .. .. .. .. .. | 82,054 | 19 | 3 |
| 2. The cost of the wharfing, terrace, and foundations for the building.. .. .. .. .. | 139,185 | 7 | 10 |
| 3. The cost of the carcase or shell already executed (exclusive of alterations as under) .. .. .. | 453,648 | 12 | 0 |
| 4. The cost of the principal alterations made from time to time. These alterations (involving changes in the original plan) consist of official residences for the librarian and clerk of the House of Commons, accommodation for the law courts, alterations of the Victoria tower, offices for the clerk of the crown, and works contingent upon the warming and ventilating arrangements, &c., which were severally reported to her Majesty's Commissioners of Woods, &c., and sanctioned by parliament in March 1843. Also, of an increase in the size and height of the Victoria hall, sanctioned by her Majesty's Commissioners of Woods, &c. .. .. .. | 25,469 | 0 | 0 |
| 5. The cost of interior finishings .. .. | 74,134 | 6 | 0 |
| 6. The cost of the internal decorations of the House of Lords and its adjuncts, as far as they have been completed (including preparations for lighting) .. .. | 21,600 | 0 | 0 |
| 7. The amount of commission and other charges paid, or to be paid, to the architect on account of works and services already executed[1] .. .. .. | 26,315 | 2 | 11 |
| 8. The amount paid to surveyors, valuers, clerks of the works, and all other persons who have been employed, and not included in the architect's or builder's charge .. .. .. .. .. | 10,861 | 5 | 8 |
| The amount of the whole expenditure of every description, under these principal heads, for purchases made and work done at the Palace of Westminster, and its appendages, up to 31st day of December, 1846. .. .. .. | £833,268 | 13 | 8 |

Estimate *for the Sums which will be required to pay for such other Lands and Hereditaments intended to be purchased for the completion of the Palace and the Approaches thereto; of the Sum required to finish the Houses of Lords and Commons and their Appendages; of the Sum necessary for the Victoria Tower, and all other Works proposed to be executed to finish the Palace.*

| | £ | s. | d |
|---|---|---|---|
| 1. The cost of lands and hereditaments intended to be purchased[2] .. .. .. .. .. | — | | |
| 2. The cost of the completion of the terrace and foundations of the buildings .. .. .. .. | 18,747 | 0 | 0 |
| 3. The cost of the carcase or shell yet to be executed | 356,328 | 0 | 0 |
| 4. The cost of the principal alterations. None proposed .. .. .. .. .. .. | — | | |
| 5. The cost of the interior finishings .. .. | 172,648 | 0 | 0 |
| 6. The cost of the internal decorations of the House of Lords and its adjuncts (including lighting and furniture) .. .. .. .. .. .. | 20,044 | 10 | 0 |
| 7. Amount of the commission to be paid to the architect:[3] .. .. .. .. .. .. | — | | |
| 8. Amount to be paid to surveyors, valuers, clerks of works, and others, not included in the architect's or builder's charge .. .. .. .. .. | uncertain | | |
| | 567,767 | 10 | 0 |
| Brought forward .. | 833,268 | 13 | 8 |
| Total Cost .. .. | £1,401,036 | 3 | 8 |

The total cost of works executed, and estimated cost of the works to be executed to finish the New Palace of Westminster, is thus £1,401,036 3 8; but which is exclusive of extra finishings, works of decoration, fittings in libraries and refreshment rooms, &c.; fixtures, furniture, and upholstery;

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[1] This amount includes (besides the professional remuneration to the architect on account of works executed to the general building) the commission upon works to the cofferdam, river wall, &c., and the sum paid for a detailed estimate, in accordance with the approved design.

[2] It is proposed, under Treasury authority, dated November 28th, 1842, to obtain possession eventually of the buildings on the south side of Bridge-street, Westminster: the probable cost of these buildings has not been ascertained.

[3] By Treasury letter, dated February 25, 1839, the sum of £25,000 was directed to be paid to the architect as professional remuneration for superintending, directing, and completing the Houses of Parliament in conformity with the original design and estimate. (It is right to state that the principle of this arrangement has never been acceded to by Mr. Barry). The remuneration to the architect on account of works not included in his original estimate, but subsequently authorised, has not yet been the subject of consideration.

warming, ventilating, and lighting, &c., except so far as such works are already executed in the finished portions of the building; also, of the restoration of St. Stephen's crypt as a chapel, if it should be so determined; the formation of landing-places towards the river, the paving of the several courts, &c., of the building, the altering of the levels, and the re-paving as well as lighting of the streets in its locality, &c. &c. The cost of which must depend on the nature and extent of the works ordered.

In this amount there is a sum of £524,099 6*s.* for charges upon the purchase of lands and hereditaments, the cost of the river wall and embankment, the warming and ventilating arrangements, and the contingent fire-proof construction of the building throughout; the additional residences and other accommodation ordered from time to time to be incorporated in the building, the increased depth of the foundations of the entire building, the main sewers for the drainage of the building and its locality, the various modifications of plan suggested and recommended by committees of parliament and other authorities, and for miscellaneous works; all of which formed no part of the original design and estimate.[4]

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MISCELLANEOUS EXPENDITURE *connected with the building of the New Palace of Westminster, not being for Purchases made or Work done at the New Houses of Parliament, or included in the Architect's Estimate for the same, but defrayed out of Grants voted by Parliament for that service.*

| | £ | s. | d. |
|---|---|---|---|
| *Preliminary Measures.* | | | |
| Premium and expenses connected with competition designs; the expense of a tour of inspection, and of experiments made with reference to the selection of the particular description of stone to be used in the building; also payment to engineers for surveys of the bed of the river .. .. .. .. .. | 4,902 | 3 | 10 |
| *St. Stephen's Chapel.* | | | |
| The expense of making drawings in detail of the chapel previous to its being taken down, and engraving the same for publication.[5] .. .. .. | 2,712 | 12 | 0 |
| *Government Wood Carving Works, Thames Bank.* | | | |
| These premises were taken to facilitate the progress of the interior finishings of the new buildings, by the erection therein of carving machines, and the employment of carvers and other workmen in the immediate pay of the Department of Woods, and under the supervision of superintendents appointed for this service, and direction of the architect. | | | |
| The expense of erecting additional buildings to afford the necessary accommodation for carrying on the works, supply of water, precautionary measures against fire, rent (to the crown), rates, lighting, &c.[6] .. .. | 11,191 | 3 | 6 |
| The expense arising from damage done or re-instatement made to adjoining property during the progress of the works .. .. .. .. .. | 1,522 | 5 | 4 |
| Payments on account of frescos .. .. .. | 538 | 19 | 9 |
| *Experimental Ventilation, &c.* (Dr. Reid's system). | | | |
| The expense of works, apparatus, salaries, and allowances in experimentally carrying out Dr. Reid's system of warming, ventilating, and lighting at the present temporary Houses of Parliament, with a view to its adoption in the new building .. .. .. .. | 8,328 | 7 | 3 |
| The expense of inquiry and reference as to the applicability of Dr. Reid's system of warming and ventilating to the new Houses of Parliament .. .. .. | 946 | 13 | 6 |
| Minor expenses .. .. .. .. | 97 | 12 | 6 |
| | £30,239 | 17 | 8 |

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STATEMENT *of the Amount of each* ORIGINAL CONTRACT, *and of every Alteration or Deviation therefrom, and the Amount paid, or to be paid, for each Contract and Alteration, and under what Authority such Alterations or Deviations have been severally made.*

### CONTRACT, No. 1 (in Gross).

| | £ | s. | d. |
|---|---|---|---|
| For the river wall, and a part of the foundations of the river front of the building .. .. .. | 74,373 | 0 | 0 |
| Additional works in the river wall, reported to her Majesty's Commissioners of Woods, &c., and sanctioned by parliament .. .. .. .. .. | 2,104 | 13 | 9 |
| | £76,477 | 13 | 9 |

### (CONTRACT No. 2 (at Prices).

| | £ | s. | d. |
|---|---|---|---|
| For the remainder of the foundations of the river front, main sewers, &c., estimated at .. .. .. | 7,442 | 1 | 9 |
| Subsequent estimates and accounts reported to her Majesty's Commissioners, &c., and sanctioned by parliament .. .. .. .. .. .. | 4,720 | 16 | 4 |
| | £12,162 | 18 | 1 |

### CONTRACT No. 3 (in Gross).

| | £ | s. | d. |
|---|---|---|---|
| For the carcase of the river front, and a portion of the north and south fronts .. .. .. .. | 157,615 | 0 | 0 |
| Change of stone, 8,500*l.*; fire-proofing, 7,200*l.*; warming and ventilating works, 10,150*l.*; reported to her Majesty's Commissioners of Woods, and sanctioned by parliament: Total .. .. .. .. | 25,850 | 0 | 0 |
| Additional cost of fire-proof floors, roofs, &c., and for warming and ventilating arrangements executed under the general authority of her Majesty's Commissioners of Woods, &c. to the architect to comply with Dr. Reid's requirements .. .. .. .. .. | 15,275 | 0 | 0 |
| Cost of stone carving upon the arrangement authorised by her Majesty's Commisioners of Woods, May 13, 1841 | 23,829 | 14 | 0 |
| Miscellaneous works ordered by the architect, under the general authority given to him to carry out his plans | 6,000 | 0 | 0 |
| | £228,569 | 14 | 0 |

### CONTRACT No. 4 (at Prices).

| | £ | s. | d. |
|---|---|---|---|
| The foundations of the central masses of the building from north to south, including the Houses of Lords and Commons, and their respective lobbies, corridors, and contiguous offices and apartments, and the foundations of the Victoria and other towers, estimated amount .. | 17,822 | 1 | 6 |
| Subsequent estimates and amounts reported to her Majesty's Commissioners of Woods, &c., and sanctioned by parliament .. — .. .. .. | 25,312 | 16 | 8 |
| | £43,134 | 17 | 8 |

### CONTRACT, No. 5 (at Prices).

| | £ | s. | d. |
|---|---|---|---|
| For the carcase of the superstructure above the foundations comprised in Contract, No. 4, estimated at .. | 219,969 | 0 | 0 |
| 1. Change of stone, 9,460*l.*; fire-proofing, 8,400*l.*; warming and ventilating arrangements, 14,616*l.*; reported to her Majesty's Commissioners of Woods, &c., and sanctioned by parliament: Total .. .. | 32,476 | 0 | 0 |
| 2. For slating to flats and roofs, asphalting walls, lengthening sewers, &c.; reported to the Office of Woods | 4,299 | 14 | 8 |
| 3. For floor plates and other structural arrangements required for ventilation, executed under the general authority given to the architect to comply with Dr. Reid's requirements; not yet brought to account and reported | 12,180 | 0 | 0 |
| 4. For iron roofs and additional cost of girders and arches rendered necessary by the warming and ventilating arrangements, and reported to her Majesty's Commissioners of Woods, &c... .. .. .. | 26,500 | 0 | 0 |
| 5. For cost of stone carving, under the arrangement sanctioned by her Majesty's Commissioners of Woods, | 21,137 | 17 | 9 |
| 6. For miscellaneous and contingent works ordered by the architect under the general authority given to him to carry out his plans .. .. .. .. | 15,000 | 0 | 0 |
| 7. For the official residences for the librarian and for the clerk of the House of Commons, accommodation for law courts, alterations of Victoria tower, enlargement of Victoria hall, increased height of Victoria hall, offices of the clerk of the crown, and works contingent upon the warming and ventilating arrangements, reported to her Majesty's Commissioners of Woods, and sanctioned by parliament .. .. .. .. .. | 25,469 | 0 | 0 |
| | £357,031 | 12 | 5 |

### CONTRACT, No. 6 (at Prices).

| | £ | s. | d. |
|---|---|---|---|
| The foundations and carcase of the superstructure of St. Stephen's hall and lobby, and the public approach from Westminster hall and St. Margaret's-street; estimated and reported to her Majesty's Commissioners of Woods, &c., at .. .. .. .. .. | 57,631 | 0 | 0 |
| For change of stone, 4,040*l.*; and warming and ventilating arrangements, 3,234*l.*; reported to her Majesty's Commissioners of Woods, and sanctioned by parliament | 7,274 | 0 | 0 |
| For iron roofs and other warming and ventilating arrangements, executed under the general authority given by her Majesty's Commissioners of Woods to the architect to comply with Dr. Reid's requirements .. .. | 5,000 | 0 | 0 |

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[4] A credit in aid towards defraying the above total estimated cost will arise from the sale of old materials, estimated to produce 14,000*l.*, and also from the sale of the materials of the cofferdam, when it has served its present purpose.

[5] A credit will arise under this head from the sale of the publication.

[6] As these premises will, after they have ceased to be used as at present, be available for other public purposes, and the additional buildings will permanently enhance the value of the crown property upon which they have been erected, this expense is not wholly to be considered as a charge on account of the New Houses of Parliament.

| | £ | s. | d. |
|---|---|---|---|
| Brought forward.. .. .. | 69,905 | 0 | 0 |
| Estimated cost of the stone carving under the arrangement sanctioned by her Majesty's Commissioners of Woods, &c., May 13, 1841 .. .. .. | 3,520 | 0 | 0 |
| | £73,425 | 0 | 0 |

| Contract, No. 7 (at Prices). | | | |
|---|---|---|---|
| For interior finishings: Amount .. .. .. | £21,407 | 6 | 0 |

| Contract, No. 8 (at Prices). | | | |
|---|---|---|---|
| For interior finishings: Estimated amount.. .. | £165,375 | 0 | 0 |

A Copy of the Original Estimate (1837).

| | | | |
|---|---|---|---|
| River Front and Returns .. .. | 211,047 | 19 | 0 |
| King's Tower .. .. .. | 79,844 | 15 | 0 |
| Clock Tower.. .. .. .. | 18,013 | 19 | 0 |
| Old Palace Yard Front.. .. .. | 50,491 | 1 | 0 |
| New Palace Yard Front .. .. | 36,112 | 12 | 0 |
| Public Entrance Approaches .. .. | 82,617 | 4 | 0 |
| House of Lords .. .. .. | 31,140 | 15 | 0 |
| Offices, Approaches, &c., to ditto .. | 62,906 | 6 | 0 |
| House of Commons .. .. .. | 35,306 | 9 | 0 |
| Offices, Approaches, &c., to ditto .. | 48,614 | 15 | 0 |
| Law Courts .. .. .. .. | 51,408 | 5 | 0 |
| | £707,104 | 0 | 0 |

## ON CAEN STONE.

*From a paper read at the Royal Institution of British Architects, on January 24th.* By T. L. Donaldson, Esq.

Being about to employ a large quantity of Caen stone in a work which is on the point of commencing, I was anxious to make myself fully acquainted with its properties and varieties, and the quantity of well-seasoned blocks that might be available in the market. I therefore determined to go to Caen itself, and visit the quarries. A few hours carries one over to Havre from Southampton, and a steam-boat conveys passengers from Havre to Caen in four hours. The last hour is occupied in mounting the river Orne, which, in its course from the sea to some distance above Caen, has a flat country on the left bank of the river, but, on the right, generally a lofty bank, at times immediately overhanging the stream, at others receding from it, but again joining it. Not far from the mouth of the Orne, at a place called Ranville, quarries are worked in the face of this bank. It is a harder and coarser variety of the same stone as that near Caen, and of more open texture, with a more crystalline character, hence more adapted for hydraulic works than for buildings. I am informed by our friend, Mr. H. C. Smith, that these coarse varieties, which doubtless are very durable, resemble in several particulars the stone from Weldon, in Northamptonshire, of which the oldest buildings at Cambridge are constructed.

The material generally known to us under the appellation of Caen stone is of the oolitic formation, presenting a close analogy in its general, and even in some of its minor divisions, with the rocks of a similar kind in the south of England. The quarries whence it is derived are situated at Allemagne, a parish and village on the right bank of the river, at the distance of about a mile and a half, or two miles, above the city. The quarries heretofore worked occupy a superficial area of about four square miles. Some are worked by means of shafts, which afford access to the quarries under ground, branching off on all sides in long galleries, or multiplied by chambers, which are about 18 feet wide, and the ceiling-bed upheld by massive rude piers, which are left 9 feet square and 18 feet apart, the height being about 15 or 20 feet. These quarries, which are immediately on the bank of the river—here abruptly rising from the water—have an access from the side of the bank, and are approached by inclined roads, leading from the summit of the bank above and from the water's edge below. The openings to these dark and gloomy caverns have a very picturesque effect, and a continued series of them present themselves one after the other. The galleries penetrate to a considerable distance. The extraction of the stone is done by contract or task work, at so much per cube, the quarrymen removing the blocks and dressing them, and another set of men contracting for their carriage from the quarry to the quay at Caen.

Immediately under the soil there are some thin courses of hard coarse stone and rubble, but the immediate ceiling-bed is called the *banc cloutier*, and is about 2 ft. 6 in. thick. It is of a hardish quality, but is not applicable for building purposes, as it contains a great quantity of pebbles, which offer great difficulties in the sawing and working. There are about six beds of good building stone, the five uppermost ones calculated for outside work, the lowermost adapted only for inside work, as it has soft portions, which do not well resist the atmosphere.[*] Much of this is used in the interior of the new Parliament buildings. The aggregate height of these six beds is from 22 to 25 feet. It is to be observed that all these beds are not to be found in every quarry, one or other of them disappearing and re-appearing in the same manner as in England. The names which I am about to give do not obtain in all parts of the district; and some of them have various designations given to them by the quarrymen. The uppermost bed is called the *banc pourri*, about 3 feet thick, which is a very good quality of stone; but occasionally it has in some portions the hard pebbles, previously alluded to, as prevailing to so great a degree in the *banc cloutier*, and therefore it is not so much esteemed for finer building purposes as the lower beds. The *gros banc* is the next bed, and has an average depth of 5 feet, but as it is inconvenient to work to that large size, it is generally split into two, in heights of 3 feet and 2 feet; and the smaller one is called the *banqueret* of the *gros banc*. *La pierre franche* bed comes next, about 3 feet deep, which is of a harder quality, and well adapted for cornices, sills, copings, and the like exposed positions in a building. Next to this is the *banc de quatre pieds*, a very fine bed, which has the same appellation, and depth of 4 feet, in all the quarries, as also the next bed, called *la pierre de trente pouces*, being 30 inches deep, a good hard bed of stone, and forming the lowest of those fit for outside purposes and exposure to the weather. The sixth and lowermost bed of the building-stone is termed the *franc banc* and has a total depth of from 4 feet 6 inches to 5 feet, but this being, like that of the *gros banc*, an inconvenient depth, it is divided into a lower thickness of 3 feet, and an upper *banqueret* of 20 or 24 inches deep. The whole of the stone of these beds is soft and tender in the quarries, and the blocks are extracted with great ease. They are produced of regular size and squareness. When taken to the outside, and exposed to the atmosphere, they gradually part with much of their humidity, and harden; and, if exposed on the quays during the winter, they are covered over to protect them from the frost. They saw freely with a common peg-toothed saw, without either sand or water, and are easily worked for building purposes; and, being of a compact fine grain, they produce very sharp arrises, and receive a very smooth surface on the face.

During the winter little work is done in the quarries in regard to extracting blocks of stone; but the men occupy themselves in sawing and squaring slabs about 12 or 15 inches square, and from an inch to an inch and a half, or more, thick, which are used for paving halls, galleries, and even some rooms inside their buildings. But the most extraordinary use to which I have seen these square slabs applied, was in the church of the Trinity of the Abbaye aux Dames. Two of the openings between the piers have been closed up, for the purpose of some repairs going on. I passed through a door in the partition or inclosure, both of which appeared to me of the same thickness. My surprise was great, and I examined the edge of the opening, and found it of stone, and discovered, upon closer inspection, that the opening, about 10 feet wide by 20 feet high, was inclosed by these square thin slabs, about an inch and a half thick, placed on edge, put together with plaister, sufficiently stable to allow a door to work in its aperture. I subsequently was told, upon inquiry, that the inside partition in rooms, 10 feet high, are formed of the same material, and secured by occasional upright studs, 10 feet apart. These partitions are admirable, for they are very light, occupy little space, and form an excellent ground to receive the plastering on the surface.

The general character given of the Caen stone is, that all the beds are of the same quality, and all equally adapted for building purposes; but evidently, from the information which I collected on the spot, and subsequently in London, from Messrs. Luard, there are modifications in each bed, as may be reasonably supposed, and as experience teaches us in the quarries of other oolitic stones in Bath and Portland. Various veins traverse the beds in all directions, and have a white appearance; this white substance is equally hard with the stone itself, and if a stone be laid with its bed parallel with the direction of these veins, it is of little consequence, but they, of course, indicate a certain unsoundness or division in that part; and if the stone be laid with this vein in a vertical direction, the block will run the chance of being fractured by a weight, or, if near the surface, it probably may admit the wet. These veins are not like those in the Bath stones, which are hard, consisting of crystallized carbonate of lime, and running always in a vertical or inclined direction, and not liable to separation. In general it is considered that the blocks of Caen stone may be placed in construction in any direction, except when the white veins are perceptible. It is said that the most experienced eye can hardly detect the different qualities of the stone in the block, when once they have been removed from the quarry, as the action of the quarryman's tool on the surface hardly offers any indication; and there is no appreciable difference in the appearance of the granular formation.

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[*] This is also the case with all the oolitic quarries in England. The uppermost beds are hardest to work, but most durable; the lower beds are soft, and will not stand the weather so well as the upper ones.

There are in the vicinity of Caen, even to a considerable distance, many beautiful varieties of this formation. At Falaise, about 20 miles off, higher up the Orne, is a fine compact stone, much harder than the Allemagne. Its texture is beautifully equal, and fine grained. Its price is one-third more than that of Caen stone, and, of course the labour upon it is considerably increased. It is well adapted for exposed situations, and is used, I believe, in the quays and dock basin now constructing at Caen.

I was, of course, anxious to ascertain whether the magnificent and ancient buildings in the city could be relied upon as proofs of the quality of the stone in the Allemagne quarries, of which there is a traditional report handed down from one generation to another, that they are constructed. And, certainly, the lofty pinnacles and spires, and the solid high square towers, which rise up in clouds, defying the fury of the elements, for many years exposed to storms, hail, rain, snow, and frost, acted upon by all the alternations of heat and cold, wet and dry, present a sharpness of arris and smoothness of surface, as seen from below, that prove a considerable degree of hardness in the stone of which they are constructed. Less reliance can be placed upon the indications on the parts within reach, for exposed as they have been to the Vandal wantonness of the revolutionary phrenzy of destruction, and the Calvanistic zeal of misguided religious feelings, there are many of the lower parts broken away and considerably worn. But the attenuated and refined details of some "*renaissance*" finials, pinnacles, and flying buttresses, in the lady-chapels and apsidal altar-ends of the churches of S. Pierre and S. Sauveur, and S. Sauveur-le-Marché of the beginning of the sixteenth century, more minutely enriched and elaborately carved and subdivided than even the most refined details of the flamboyant parts near them, are as fresh and sharp as if executed within the last fifty years. Time and weather have not had, on the monuments of Caen, the same corroding hideous influence as on the edifices of Chester, Coventry, or Oxford. The graceful spire of S. Pierre, the summit of which is 250 feet above the market-place, and itself more than 100 feet high, does not appear to be thicker than 9 inches in the lower part, and is reduced, it is said, to 4 inches thick at top. The immense weight and exposed situation do not seem to have affected it in the least degree; and it may be quoted, if not for size, at all events for its grace, daring construction, and state of preservation, after 540 years' trial, with its sister spire of our own Salisbury, erected at the same period.

At the same time, I am not prepared to assert whether the stone employed was all taken from the Allemagne, or from some other superior quarries; but the appearance of the stone justifies the tradition of its origin, and I know not how to question it.

## CONWAY TUBULAR BRIDGE.

*Experiments on the Completed Structure.*

We are glad to be able to quote from a contemporary an account of the experiments on the tubular bridge just completed, as given by Mr. Fairbairn himself, in a letter to a friend :—

> "We have solved an important problem in practical science; and, despite the prognostication of some eminent mathematicians, the whole of my experiments at Millwall have been more than realised. On Wednesday last, the tube was suspended upon temporary piers, 400 feet span; and with its own weight (1,300 tons), the deflection did not exceed, but was under, 8 inches. With 300 tons of loaded trucks, the deflection was increased to 11 inches—being, as near as possible, in the ratio of 1 inch to 100 tons of load. The computed breaking weight of the tube is 2,200 tons equally distributed, exclusive of its own weight; and, having its perfect retention of form and great rigidity, I am of opinion that it would sustain 3,000 tons before fracture took place."

It appears from this account, that the deflection under a load of 300 tons, is less than one foot—an amount which Mr. Fairbairn considers so small as to demonstrate the successful issue of the undertaking in which Mr. Stephenson, with the able co-operation of himself and Mr. Hodgkinson, is engaged. Certainly, when we consider the length of the structure, the multiplicity and complexity of the component parts, and the number of joints and rivets—the accuracy of adjustment, and the extreme nicety of workmanship which effect the result stated, must appear wonderful; and the superintendents of this great work, who have concerned themselves in its minutest details, and therefore have the fullest sense of its difficulties, must naturally estimate this amount of success more highly than comparatively uninterested persons can do. But iron, even of the best quality, is not perfectly elastic; bolts and rivets, though ever so carefully formed, are not mathematically true; and, therefore, it may reasonably be asked, if the structure sink one foot now, how much will it sink when the bolts have been worn, the bolt-holes enlarged, and the plates strained by the wear and tear of six months' railway traffic?

It is to be remembered, also, that the dynamical effect on the structure of a load in motion, is much more than the statical effect of a load at rest. In the case of a jointed structure, of which the elasticity is imperfect, the dynamical strain and deflection would be certainly double the corresponding statical effect.

These remarks are not intended as forebodings as to the ultimate success of this magnificent undertaking. All that we wish to do is to point out how much of the problem is solved, and how much remains in doubt. Considering the question abstractedly, we cannot deny the possibility of making the structure strong enough to bear its load. Theoretically, a tubular bridge may of course be made strong enough to bear any assignable load whatever—ton after ton of metal might be added till the requisite strength would be obtained. For as each ton of metal would be disposed so as to bear something more than its own weight, we should, by continuing the process of increasing the thickness of the plates, arrive ultimately at a point where the strength was sufficiently in excess to sustain any load assigned.

But the question is, not whether the bridge may be made strong enough, but whether it be made so at the least expense of material. It is to this point our doubts refer. Mr. Fairbairn says, that his experimental results contradict the conclusions of some eminent mathematicians; and, except for the laudatory epithet, we should be disposed to think that he refers to investigations which have, from time to time, appeared in this *Journal*, in which alone, we believe, the mathematical principles of the tubular bridge have been discussed on an extensive plan. But leaving the personal question, it is enough to explain that we call in question not the effect, but the means; not the sufficiency of the structure, but its economy. It has been already shown (Vol. IX. for 1846, p. 300), that *straight* tension rods, proceeding in right lines from high suspension towers to several joints along the tube, would act with the greatest possible efficiency. It is not even now too late to apply the suspension rods to the bridge: only let it be by rectilineal rigid diagonal bars—not by flexible or catenary chains. Comparing equal quantities of metal disposed—first, in increasing the thickness of the tube—secondly, in *diagonal bars*, acting either as struts beneath the tube, or as tension rods above it,—it has been mathematically demonstrated that the efficiency of the metal may be trebled by the second method. Were it not dangerous to prophesy on a subject so novel and so difficult, we should be inclined to predict that this second method, in one or other of its forms, of diagonal tension rods or diagonal struts, will be found necessary after the structure has been some time in use.

## NOTES OF THE MONTH.

*The Tabernacle.*—Among the interesting exhibitions now open is that of the Tabernacle of Israel, at 58, Pall-Mall. The Rev. R. W. Hartshorn, a clergyman of the University of Dublin, feeling an interest as to the form and structure of the Tabernacle, has had a model made, with all the details elaborately executed, as gold and silver candlesticks, brass sacrificial instruments, and embroidered curtains. The models are two in number, and are executed in strict conformity with the texts in the bible, which describe the arrangement of the original Tabernacle of the Jews. The first of these models represents the Jews encamped in the plain of Moab, with the tribe of Levites and the Tabernacle in the centre. The tents of Ephraim are shown in the distance, and afar off the Dead Sea and the mountain range. This is a most interesting tableau. The other model is devoted to the illustration of the court of the Tabernacle in greater detail. Here are shown the sixty pillars, the altar of burnt offering, the embroidered curtains, and all the accessaries of the place of worship. The water-vessels are copied from authorities in the British Museum; the pillars are gilt, the candlesticks and vessels are of gold and silver, and the model of a high priest stands at the altar, superintending a sacrifice. This exhibition is an extraordinary example of the practical illustration of a text, and is likely to excite very great interest, from the nature of the subject and the mode in which it is carried out.

*Sewage Pipes.*—Glazed-ware pipes for sewers have become a large article of manufacture since the late sanitary agitation.

*Water Works.*—In the new sanitary bill, provision is made to enable the new commissioners to set up water and gas works.

*Death.*—Mr. Charles Dyer, a member of the Institute of British Architects, has died of paralysis. His works are chiefly at Bristol; and include the Victoria Rooms, with a large Corinthian portico; the Bishop's College, in the Gothic style; Christ Church, Clifton; Bedminster, New Church; and the Female Orphan Asylum.

*New Theatre.*—The Royal Polytechnic Institution has been nearly doubled in size by the erection of a very large theatre, capable of holding a great number of persons.

*Decoration.*—Regular courses of lectures are now being given at the School of Design, Somerset House.

*New Gallery.*—In consequence of the gift of the Vernon collection, the government have obtained a committee of the House of Commons to inquire into the accommodation at the National Gallery, and what provision ought to be made for the national collections. This will result in a new building.

*Builders' Foremen.*—The Institution of Builders' Foremen has reached its third year. Its first investment of £100, 3¼ per cents. has been made.

*Windows.*—An agitation is being carried on to get rid of the window tax, and as it is supported on sanitary grounds it is likely to be successful, though the government have refused to do anything this year.

*Death.*—The newspapers announce the death of Lieut. Col. Henry Brandreth, R.E., one of the paid Railway Commissioners. He was a very distinguished member of the Corps to which he belonged. His death was sudden.

*Dividends.*—The railway dividends declared at the half-yearly meetings have been more satisfactory than was expected; while a complete denial has been given to the charge that dividends have been paid out of capital.

*Broad Gauge.*—The course of litigation has been latterly in favour of the broad gauge, and it is expected the Great Western will be left masters of the Birmingham and Oxford line.

*Telegraph.*—Mr. Wishaw is, it is stated, engaged on an hydraulic telegraph, of which system, as is well known, he was the inventor. He organised the establishment of the Electric Telegraph Company.

*Colonies.*—Colonial railways are quite at a stand-still: the Demerara works are stopped, the new Jamaica lines given over, and the Trinidad and Barbadoes Companies defunct.

*Survey.*—The ordnance surveyors have begun the survey of London, for fear they should be stopped. Mr. Wyld gave some opposition in the House of Commons, but the surveyors have been so supine, that the government have been able to carry out their own system.

*Blackburn.*—On the 18th ult., a new market-house was opened at Blackburn. It is by Mr. Terence Flanagan, C.E., and is 181 ft. 6 in. long, and 109 ft. 6 in. wide. The roof is in three spans. The tower is 18 feet square, and rises 90 feet high. The material is Longridge stone, and the cost £800.

*Flaxman.*—A collection of 150 works of Flaxman has been presented to the University College by Miss Denman, his executrix.

*Saltash Bridge for the Cornwall Railway.*—The estuary of the Hamoaze at Saltash Passage, is, at high water, about three-quarters of a mile wide, 10 fathoms more or less deep, and, from its narrowness compared to other parts, the stream runs there with a most powerful force. It is designed to carry over the river, at this passage, a bridge of three arches, 95 feet above the surface of high-water spring tides. To aid in the accomplishment of this great object, the Cornwall Railway Company have purchased two 14-gun packet brigs—the *Pigeon* and *Magnet*—of 300 tons each, and have moored them at the passage about midway. By a series of moorings, it has been ascertained that the bed of the river is covered with mud to depths varying from 18 inches to 15 feet. On the Cornwall side, a stage being moored 20 feet from the beach at low water, and a 30-bar ladder with weights attached, let down to rest on the ledge of a steep rock, a diver had yet to descend 9 feet before the bottom was obtained. On the Devonshire side there is not so much declivity. The company have just received from Bristol, by Bristol and Exeter and South Devon Railway to Totness, and thence by sea, an immense cylinder, weighing 23 tons, 85 ft. 9 in. long, and 6 ft. 3 in. diameter. It is designed to let this cylinder down perpendicularly between the two brigs, when it will be about 25 feet out of the water, and in that position to moor it with hemp cables, fastened to four or five anchors, some of which weigh 1 ton each, purchased expressly from her Majesty's dockyard. An effort will then be made to pump the cylinder dry, by steam-engines to be fixed on board the brigs. Should the experiment with this cylinder prove successful, it will have to give place to one of much greater magnitude, weighing 130 tons, of the same length, but having a diameter of 30 feet—thus providing an area of sufficient extent to lay foundations for the piers of this formidable work. At the present season there are not more than about 30 men employed at Saltash; but a far greater number will shortly be employed. They are under the control of the resident engineer, Capt. Donce, who is aided by Mr. Pope, the gentleman who so ably assisted in floating the *Great Britain* steam-packet.

## LIST OF NEW PATENTS.

GRANTED IN ENGLAND FROM JANUARY 22, TO FEBRUARY 23, 1848.

*Six Months allowed for Enrolment, unless otherwise expressed.*

Henry Heywood, of Blackburn, Lancashire, for "certain Improvements in looms for weaving."—Sealed January 22.

William Hudson, of Burnley, Lancashire, machine-maker, and John Dodgeon, of Burnley, same county, overlooker, for "certain Improvements in looms for weaving."—January 22.

Henry Hornblower, late of Dalgleish-place, Commercial-road, Middlesex, but now of Devon's-lane, Bromley, engineer, for "certain Improvements in machinery for exerting motive power, and for raising and forcing fluids."—January 25.

Thomas Topham, of Ripley, Derbyshire, manufacturer, for "Improvements in the manufacture of time-tables."—January 25.

George Fergusson Wilson, of Belmont, Vauxhall, gentleman, for "Improvements in treating and manufacturing certain fatty or oily matters, and in the manufacture of candles and night-lights."—January 25.

Henry Highton, of Rugby, master of arts, and Edward Highton, of Regent's Park, Middlesex, for "Improvements in electric telegraphs."—January 25.

James Barr Mitchell, M.D., and Thomas Best Woolryche, chemist, for "Improvements in the manufacture of soda, and in treating products obtained in such manufacture."—January 25.

John Collins, of Leominster, in the county of Hereford, architect, for "certain Improvements in furnaces, stoves, grates, and fire-places, and in kilns and other apparatus for preparing vegetable and other substances, and the generation and application of heat." January 27.

Thomas Robinson, of Coventry, ribbon manufacturer, for "Improvements in looms for weaving ribbons and other fabrics."—January 27.

William Watson Pattinson, of Felling, near Gateshead, Durham, chemical manufacturer, for "Improvements in the manufacture of soda."—January 27.

William Henry Barlow, of Derby, civil engineer, for "Improvements in the manufacture of railway keys."—January 27.

William Russell, of Lydbrook, in the county of Gloucester, iron master, for "an Improvement in the preparation of such bar-iron as is used in the manufacture of certain kinds of rod-iron."—January 29.

Alfred Vincent Newton, of Chancery-lane, mechanical draughtsman, for "Improved machinery for manufacturing shot and other balls." (A communication.)—January 31.

James Blackwell, of Winsford, in the county of Chester, salt proprietor, for "certain Improvements in evaporating furnaces."—February 2.

Robert Fowles, of North Shields, Northumberland, gentleman, for "certain Improvements in propelling."—February 8.

James Bird, of the Cwm Avon Works, Taibach, Glamorgan, gentleman, for "certain Improvements in propelling."—February 8.

Godfrey Anthony Ermen, of Manchester, cotton spinner, for "certain Improvements in machinery or apparatus for twisting cotton and other fibrous substances."—February 8.

Richard Clarke Burleigh, of Featherstone-buildings, Middlesex, gentleman, for "Improvements in burners for obtaining or producing light and heat, and in apparatus to be used therewith."—February 8.

Jacob Brett, of Hanover-square, Middlesex, gentleman, for "Improvements in electric printing and other telegraphs."—February 8.

William Heywood, glover, of Stone Bridge, Chester, chemist, for "Improvements in the manufacture of oil from blubber."—February 8.

William Sangster, of Regent-street, Middlesex, for "Improvements in umbrellas and parasols."—February 8.

Jean Napoleon Zermen, of Greenwich, Kent, captain in the French navy, for "Improvements in ships and other vessels."—February 8.

Luke Hebert, of Ryde, Isle of Wight, civil engineer, for "Improved mechanism for reducing, grinding, and sifting bark, sugar, coffee, seeds, and other substances."—February 8.

William Peter Piggott, of Oxford-street, Middlesex, and Wardrobe-place, Doctors' Commons, city, for "certain Improvements in nautical instruments, and in the manufacture of cases for containing instruments, goods, or merchandise."—February 8.

Jean Marie Magnin, of Ville Granche, (Rhone,) France, avocat, for "Improvements in machinery for sewing, embroidering, and for making cords or plaits."—February 9.

Gustav Adolph Buckholz, of Forston-street, Middlesex, gentleman, for "Improvements in obtaining motive power."—February 9.

Felix Douche, merchant, of Rouen, France, for "certain means, processes, and apparatus used for saving and applying the lost heat in general and sometimes direct heat, to many useful purposes." (A communication.)—February 10.

William Jeary Cannon, of Cambridge, solicitor, for "Improvements in the construction of carriages for the conveyance of sheep and other animals on railways."—February 11.

The Right Hon. Thomas, Earl of Dundonald, Vice-Admiral of the White squadron of Her Majesty's fleet, Knight Grand Cross of the Most Hon. Order of the Bath, for "Improvements in marine steam boilers and apparatus connected therewith."—February 11.

Horatio Black, of the town and county of Nottingham, lace-maker, for "Improvements in evaporation."—February 14.

John Watson, merchant, and Edward Cart, gentleman, both of Hull, for "Improvements in the manufacture of gas."—February 14.

James Timmins Chance, and Edward Chance, of Birmingham, for "Improvements in furnaces, and in the manufacture of glass."—February 14.

William Tottie, of Crosby-square, London, merchant, for "Improvements in distilling." (A communication.)—February 14.

John Weston, of Portland-town, Middlesex, machinist, for "certain Improvements in obtaining and applying motive power."—February 16.

Joseph Barber Haxby, of Dewsbury, for "Improvements in making communications between the guards, engineers, and other servants in charge of railway carriages, and also between the passengers and such servants, which improvements are applicable generally where speedy and certain communications are required."—February 16.

Edward Massey, of Middleton-square, Middlesex, watchmaker, for "Improvements in logs and sounding apparatus."—February 18.

Edward Duncombe Lines, of Chelsea, and Samuel Luiz Freemont, of Love-lane, City gentleman, for "Improvements in the manufacture of colours, oils, and varnishes, and in the manufacture of charcoal, and also in treating vegetable substances for, and in obtaining extractive matters therefrom."—February 18.

William Irving, of Trigon-road, Kennington, engineer, for "Improved apparatus for cutting or carving ornamental forms in wood, stone, and other materials."—February 23.

James Nasmyth and Holbrook Gaskell, both of Manchester, engineers, for "certain Improvements in machinery or apparatus for forging, stamping, and cutting iron and other substances."—February 23.

## CANDIDUS'S NOTE-BOOK, FASCICULUS LXXX.

> "I must have liberty
> Withal, as large a charter as the winds,
> To blow on whom I please."

I. Caryatides completely contradict Vitruvius's conceit, as to Ionic and Corinthian columns being proportioned respectively after Grecian mammas and misses, for the real feminine or lady-like pillars are far more bulky and robust than even the most masculine examples of the Doric order,—to such degree, in fact, that they would be positively clumsy were they mere pillars, whereas variety of form and play of outline entirely dissipate the heaviness which would attend simple masses of stone of the same bulk. Of the effect and value of Caryatides in architectural composition scarcely anything is said by architectural writers, although it is that which chiefly demands their consideration and remark; for as to the origin or first introduction of such figures to perform the office of columns, that in reality matters not a rush, notwithstanding it is what exclusively occupies the attention of those who speak of them. The current legend respecting the adoption of them into Greek architecture, may be true or may be false; but at all events it is not necessary in order to account for pillars being shaped to resemble human figures, such figures being frequent in the Egyptian style,—of course with very wide differences as to taste and design, the fundamental idea being nevertheless one and the same. Far more to the purpose is it to consider the æsthetic effect of such statue-columns, and their value in architectural composition. That while they greatly extend the resources of the latter, there is direct classical authority for them, and that in an example fraught with the most exquisite taste, is undeniable; notwithstanding which, the propriety of the taste so displayed has been called in question, or rather has been peremptorily condemned. It is contended that such figures both suggest painful ideas, and partake of the preposterous. With regard to the first of these objections, it is difficult to understand wherefore statues performing the office of pillars should excite any idea of pain if they themselves express no such feeling—which of course they ought not to do—but stand calm, immoveable, and indicate perfect ease and tranquillity. As to the preposterousness of employing human forms for offices which living human beings could not possibly perform, if there be absurdity in that, it is of a species which extends itself—or I might say, incorporates itself—with a very great deal of both architectural decoration and ornamental design generally. It has been said that whatever is contrary to common-sense is contrary also to good taste. The validity of such dictum depends very much upon the latitude allowed to the term "common-sense." If we are to understand by it merely the knowledge based upon actual experience, a very great deal that has hitherto been regarded as manifesting refined taste, must be set aside altogether, and pronounced to be in very false taste. If Caryatides are to be condemned as inconsistent with good taste, because they represent the human form contrary to what we know by common-sense it is capable of, the same authority of common-sense must pronounce statues employed as pinnacles and acroteria on pediments or elsewhere to be equally repugnant to good taste, they being placed for a continuance where real persons—if they could stand there at all—could remain for only a few minutes, and that at the peril of their necks and limbs. Again, how can we reconcile with plain common-sense such classical monstrosities as arabesques or human and animal figures terminating in foliage? Nay, is there anything of common-sense—that is, of plain, honest, matter-of-fact common-sense—in the cramming a crowd of figures into a pediment, where half of them are, perforce, crouching down? Or what shall we say to such conceits as corbel-heads, or to statues fixed in between the mouldings of the head of an arch, in such manner that some of them are nearly in a horizontal position? If common-sense is not startled by them, it may surely excuse what are less at variance with it—namely, Caryatides, which last are at once so picturesque and elegant in effect, that their being so rarely employed may well excite our wonder. Their being frequently employed is not to be looked for, on account of their expensiveness as compared with other pillars of the same dimensions; still what prevents their becoming too common by being applied on ordinary occasions, should operate as a strong reason for introducing them where magnificence is affected, and cost becomes a secondary consideration.

II. From what Mr. Gwilt says on the subject, in his Encyclopædia, it would seem that Caryatid figures are by no means uncommon features in architectural composition, for he tells us that "the variety in quest of which the eye is always in search, and the picturesque effect which may be produced by the employment of Caryatides, leads *often* to their *necessary* employment." How he reconciles the epithet "*necessary*" with the opinion uttered by him just before, viz., that the purpose of support can be not only as well but even better accomplished by a small order,—must be left to himself to explain, which it would, perhaps, puzzle him to do; and puzzle him also it would to justify the expression "*Often*," by enumerating examples. On the contrary, they are exceedingly rare indeed, in this country more especially, for I can call to mind only one instance of the kind in the metropolis, namely, that afforded by the church of St. Pancras. Yet, though he evidently entertains no partiality for Caryatides, Mr. Gwilt appears to regard with favour Inigo Jones's idea for the circular court in the palace of Whitehall, which was intended to have two orders of colossal figures, answering to two entire stories of the edifice, which enlargement of scale for figures of the kind is certainly no improvement upon the tasteful Athenian example.

III. It would be well were we to ask ourselves what is likely to be the result of the present system of architectural copyism and mere reproduction. The works so formed and fashioned will, by and by, come to be looked upon, at the best, only as so many clever counterfeits and imitations of what were previously living styles of the art, fraught with vitality and with the actual impress of the period when they respectively flourished. Just now, while we are imitating, our imitations may interest ourselves, but they will be of no interest or value to those who come after us. Historic interest they will have none, except as testifying to our skill in mechanical mimicry, and our utter want of inventive and creative power. Do what we will, imitation of something done before there always must be in architecture; yet, as if that were not sufficient, we affect and pique ourselves upon direct and express imitation. We must always have "something after somebody," or after something else. And this of itself constitutes a prodigious difference between the art at the present day and in former periods, our own being little better than a blank with regard to original ideas. So that with all our reverence—real or pretended—for precedent, we refuse to recognise the artistic liberty to which we are indebted for those styles and examples of them which we now cry up as patterns of excellence.

IV. The free exercise of invention in design is not to be confounded with mere arbitrary innovation. The inventive power for which such freedom is claimed must, however, be of a legitimate kind,—that is, be directed by sound principles of art. With them and a cultivated taste for his guidance, he who has the spirit of an artist in him may safely be trusted to his own impulses and ideas; whereas he who has no insight into artistic principles, who has never applied himself to æsthetic study, cannot be trusted at all beyond the limits of the most ordinary common-place and jog-trot design, for if there be a possibility of blundering he is sure to do so. No matter in what style he attempts to disguise himself, his vulgarity is certain to betray him, and his irrepressible Pecksniffism breaks out, without being at all suspected by him, or it being in his power to guard against it, for the simple reason that it is his nature, and he has no idea of what he ought to guard against. Daily experience confirms the truth of this: how many atrociously vile and vulgar copies—or rather parodies and caricatures, although intended for copies—do we see of styles and modes of design and composition that happen to have been brought into vogue—as, for instance, the astylar "Palazzo" fashion introduced by Barry, which has in many cases been either positively vulgarized, or else treated in the most prosaic manner,—as if the intention were to prove what miserable taste may be displayed in things that affect to conform to precedent and to be perfectly free from caprice.

V. As to caprice, that term is frequently applied very unmeaningly. It is very common for people to set down at once for caprice whatever deviates from general rule and usual method; thereby perplexing that ordinary and petty criticism which has no other standard of judging than established routinier precepts, interpreting them, moreover, to the very letter. Such criticism is unable to discriminate between what is mere caprice and what is not,—wide as is the difference between them. The capricious is that for which no satisfactory reason can be assigned by the author of it; but, however contrary it may be to usual practice, that is not caprice which is done with deliberate intention and well-studied aim at effects previously untried. And if to do well merely according to precedent be meritorious, much more so must i be to do so and at the same time go beyond actual precedent, creating what in its turn will be recognised as valid precedent and authority. It is proper enough to be perfectly well acquainted with precedent, but to be tied down to it—to be made a slave to it, is ill. Those who are incapable of thinking for themselvs, take refuge in precedent, and make it their stronghold, since it enables them to assume a tone of authority, and to decide dogmatically without any trouble of thinking.

VI. Careful observance of rules will enable any one to avoid positive faults; but between them and positive merits there is an immeasurable distance—one which defies calculation. In art, it is very possible to be at once faultless and valueless—without any specific fault, but also without any interest or any charm,—in a word, to be altogether humdrum. Perhaps it is rather unfortunate than not for architecture, that a great deal of humdrum is of necessity tolerated in it: however worthless or unworthy they may be as productions of architecture, buildings may as buildings completely answer the purpose for which they are erected. Besides which, they must, when once erected, remain indefinitely, to the discredit of the art and the corruption of public taste. Humdrum poetry becomes serviceable as waste-paper; humdrum pictures find their way into lumber-rooms and garrets; but buildings of the same or even worse quality cannot be so got rid of, or put out of sight; otherwise a good many that might be mentioned would now disappear.

VII. There is something startling, perhaps diverting also, in the decidedly opposite opinions entertained by two of our architectural professors with regard to Vitruvius. While Professor Hosking speaks of him, in his Treatise on Architecture, in the most unqualified terms of contempt, Professor Cockerell venerates him;—as to vindicating him, that is quite a different matter, and what he does not even so much as attempt, but leaves altogether unnoticed the highly depreciatory remarks thrown out against his idol, not by Hosking only, but by the author of the "Newleafe Discourses," both in that publication and elsewhere. The ignoring them may be prudent enough, but assuredly does not show much of either courage or ingenuousness, keeping quite out of sight as it does the fact that Vitruvius has of late years been violently impugned by professional writers in this country, and his work declared valueless to the architectural student;—nay, not only valueless, but in some degree mischievous also, by filling him with absurd and idle notions, and affording him no insight whatever into his art,—as art. If Vitruvius has been unjustly aspersed and vilified, it was for Professor Cockerell to defend him—if he could; instead of which, in his closing lecture this season at the Royal Academy, he gave his hearers reason to suppose that the chief accusation brought against him had been by his German editor, Schneider, on the score of his Latinity. Schneider, it seems, was a mere philologist, and honestly avowed his ignorance of the subject-matter of Vitruvius's writings, which I take to have been rather in favour of his author than the contrary, because, had he been capable of judging of the value of the matter also, hardly would he have entertained a higher opinion of him. The name of Vitruvius is, undoubtedly, one of great traditional fame—one sanctified by inveterate prejudice, partly or even principally because his books *De Architecturâ* represent to modern times all that remains of similar writings by the ancients. That mere accident has conferred upon him a monopoly of reputation, there being no one to share it with him; and it has been too lightly taken for granted, that, writing in classical times, he must himself have been a competent judge and expounder of classical architecture. He shows himself, however, to have been at the best of a very plodding turn of mind—notwitstanding his pompous and priggish proems, and to have been what would now be called a mere "practical man," acquainted only with matters of routine and the technicalities of his craft. While there is a very great deal in his work which is utterly irrelevant, it being only in the remotest degree connected with the professed subject, there is absolutely nothing whatever that gives evidence of the artist or the æsthetic critic. There is not so much as any attempt to lay down and explain principles of correct taste in architecture. There is neither argumentative criticism, nor reasoning, nor remark; but everything is treated in the dryest manner conceivable, and for the most part very obscurely also. What is to us his obscurity may partly be laid to the charge of our own ignorance—our not being better informed as to various matters that were sufficiently well understood by those to whom he addressed himself, but which, after all attempts to explain them, can now only be guessed at. The question then, is, of what value is Vitruvius to us, especially at the present day, when by means of various ancient buildings and examples that have been from time to time discovered, explored, and delineated, we have obtained a far clearer insight into the principles and practice of the architects of antiquity than can possibly be derived from the writings of Vitruvius? In some instances, obscurities in his text have been explained by what has been observed in extant monuments; yet that only proves that the latter are infinitely more intelligible instructors than Vitruvius, and that accordingly he may now be dismissed by us, for any real advantage to be derived from the study of him. Such study will, indeed—if that be any advantage—enable the architect to talk learnedly, but will not help in the least towards making him an artist; rather will it be apt to render him a pedant, and obstruct the advance he might else make in his capacity of artist, by withdrawing his attention from what is his proper study as such; as has too frequently been the case. Many would have been far greater proficients in their art, if, instead of poring—perhaps stupifying themselves also—over Vitruvius, they had thrown him entirely aside, and exercised their own powers freely in composition and design.

VIII. The subject of the invisible—perhaps altogether imaginary—curves in the lines of the Parthenon has been again brought forward before the Institute, though it was to be hoped we should hear no more of it. Matters of far greater immediate importance than such *nugæ difficiles* and refined subtilties and speculations, claim our attention, ere we advance so far as to be able to appreciate such exquisite niceties in architectural optics as those attributed to the Greeks. Little less than ludicrous is it for us to pretend to interest ourselves with them, when we complacently tolerate the most crude and spiritless school-boy imitations of classical architecture, which chiefly show how very ill the pretended originals have been understood. So long as we shut our eyes to the glaring barbarisms in taste, and the harsh contradictions with regard to style, that are allowed to manifest themselves in copies of that class, it is in vain to expect that we shall ever open them wide enough to discover such philosophically-studied minutiæ as are the curvatures in question, which certainly were not even so much as suspected till very recently, notwithstanding the diligence with which the Parthenon has been examined, not only by Stuart, but by many others since his time. It has been ascertained beyond contradiction, that Polychromy was—to a certain extent, at least—employed as an effective and legitimate mode of architectural embellishment, both for the Parthenon and other Greek structures; and yet even that discovery has been altogether useless to us in practice, inasmuch as we have not attempted to avail ourselves of it on any occasion: and if we forego a trait of Grecism that would be plainly perceptible to every one, hardly is it to be supposed that we shall ever think of making any use of refinements in optical effect that would not be perceptible to one person in ten thousand. Let us provide the shirt before we think of the ruffles for it: when we can show that we are capable of fully entering into the character of classical architecture with genuine artistic sentiment for it, it will be time enough to think of those exquisitely subtile and delicate touches which are now imputed to the Parthenon. For us, who show ourselves so obtuse as we do to many even tolerably palpable qualities in Greek design, to concern ourselves with its finest imperceptible workings, is nothing less than absurd. Besides which, Grecian architecture has of late fallen into discredit with us, we having at last found out that, as our buildings are necessarily constituted, it is nearly altogether inapplicable by us in actual practice. Copy Greek orders we may, but we cannot keep up—except in very particular cases indeed—anything like the genuine Greek physiognomy; so that the degree of resemblance aimed at and obtained, only serves to render the departure from the original style the more evident, particularly if the order be the Doric, since that refuses to accommodate itself to any other purpose than a simple colonnade.

IX. So very far are we from studiously calculating optical effects with mathematical precision, that we do not seem to understand—at least, not to be able to foresee—that difference of appearance which takes place between a geometrical elevation, in which every part shows itself equally distinctly to the eye, and the building executed from it, in which last it is perhaps afterwards discovered that much of the detail does not tell at all. Seldom is any calculation made with reference to the actual locality, and the distance from which the structure itself will generally be viewed. Hence, when erected, it is sometimes discovered that a building can be seen only so far off that its lesser features are scarcely distinguishable at all, or else only from so close a point of view, that all the upper part of it becomes so greatly foreshortened as to become quite distorted, and altogether a different object from what the geometrical design promised. It is not uncommon, again, to find that while those parts which can be but imperfectly seen—or at the best seen only in their general forms—are elaborately decorated, those which being almost close to the eye show themselves distinctly, are comparatively neglected and treated as subordinate ones;—and so they may be with regard to the design as seen upon paper, but not as it is seen in the building itself. In many cases, the merest indication of detail and finish would answer the purpose just as well as that degree of the latter which is now deemed indispensable, although the parts to which it is applied may be out of sight, or nearly so. Therefore, I cannot help taking the river front of the new Palace of Westminster to be a very great mistake, and a very costly one also. However exquisite may be its beauties of detail, they are valueless if, as really is the case, they are invisible, and cannot be enjoyed by being admired.

X. What is or is not a palace seems to be difficult to say, when we find among the examples referred to under that designation, in the index to Cresy's translation of Milizia's Lives, not only Barbers' Hall, the Horse Guards, Heriot's Hospital, and other buildings which do not seem to belong at all to that class, but also the Monument on Fish Street Hill! We may therefore congratulate ourselves on having besides that, two more palaces which we have not reckoned before—namely, the Nelson and the York Palaces. A most agreeable surprise must it be to Mr. Railton, to find that he has erected an entire palace when he attempted only to stick up a single column.

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## THE HOTEL DE VILLE, PARIS.

*Hotel de Ville de Paris, Mesuré, Dessiné, Gravé, et Publié, par* VICTOR CALLIAT, *Architecte ; avec une histoire de ce monument, par* LE ROUX DE LINCY. Grand folio. Paris, 1844.

As the seat of the Provisional Government of the new French Republic, this edifice has recently acquired a degree of interest even with those who would be wholly indifferent to it as a work of architecture. Of course, it is as the latter alone that we notice it, and had the same means of doing so been afforded us, should have done so before. Still, late as we are in our notice of the splendid architectural publication whose title heads this article, we are not at all behind others, for we are, we believe, the very first to make mention of it in this country. It may sound oddly to say that we *hasten* to give our readers some account of it ; nevertheless such is the case, because, anxious to speak of it without further delay, just at the moment when circumstances give the building an incidental importance, distinct from that which it possesses as an architectural subject, we are at present prepared for reporting only of the graphic part of the work, having no time to examine the literary one. The latter is, in fact, so exceedingly copious, and contains such a vast mass of historical matter, as to require very patient study, more especially as the form in which it is given is a highly inconvenient one for either perusal or reference. In our opinion, it would have been greatly better to publish the plates by themselves, or with only so much letter-press as was requisite for explaining them, and describing the present edifice architecturally ; the history being made to form a separate octavo volume, either as a distinct work or not, as might be deemed expedient. Had that been done, both the folio volume or atlas of plates, and the octavo of text, would have answered their respective purposes much better than is now accomplished. The former would not have been so inconveniently bulky ; the other would have been a readable volume, whereas now, however readable the matter itself may be, hardly can it be said to be in a readable shape ; whence the probability is, that very few will encounter the fatigue of reading it at all. The perusing the text continuously in its present shape would, to ourselves at least, be a formidable task ; yet, fortunately, we are not particularly solicitous about matters of mere historical record,—events and transactions which have no other relation to the edifice itself than what is derived from the latter having been the locality where they occurred.

Leaving M. Le Roux de Lincy's portion of the work, we shall confine ourselves to M. Victor Calliat's department of it, who, we should observe, holds, or lately did hold, the office of *Inspecteur* of the building, and who employed five years in carefully measuring and delineating the various parts of the structure, having, besides, free access to the designs of MM. Godde and Lesueur, the architects employed for the new work. Until the recent amplification and alterations, which have rendered it one of the most important monuments of the French capital even in its present greatly improved and embellished state, the Hotel de Ville was of little architectural note, except as a *souvenir* of old Paris. The style of it had been voted "*Gothique*" and obsolete ; and the actual design showed much more of the grotesque than the beautiful. All that Woods says of it in his "Letters," when speaking of the buildings of Paris, is : "It has a certain richness of appearance, although it is not in a style of architecture capable of great merit (?) and even not one of the best examples of the sort. It is, however, as good as our Guildhall." As good as our Guildhall!—as well might he have called it at once intolerably bad.

The original edifice that forms the nucleus of the present greatly extended mass, was commenced in the reign of Francis I., viz., in 1533, after the designs of Domenico Boccadoro, or Boccardo, otherwise called Domenico di Cortona, assisted by Maitre Jehan Asselin, and the façade and the "Cour d'Honneur," now the middle one of the three courts, were completed in 1541 ; and much was subsequently done from time to time. At the period of the first Revolution, the edifice suffered greatly ; many sculptures and embellishments that were obnoxious to the enlightened populace were destroyed ; among others, a series of portraits from the 16th century, and a number of large paintings by Porbus, de Troyes, Largilliere, Mignard, Vanloo, and other masters,—or if not actually destroyed, removed, nor is it now possible to ascertain what has become of them.

During the Empire and the Restoration, the edifice underwent some partial alterations ; but it was not until 1836 that it was determined to undertake improvement upon a comprehensive scale ; and great as it was, the scheme has been carried out so successfully that the Hotel de Ville may be placed foremost among the architectural monuments that mark the reign of Louis Philippe.

If not particularly remarkable in itself, remarked it may be, that this edifice, which is, in some degree at least, similar in purpose, is also contemporaneous with our own new Palace of Westminster, except that it is already completed, while the completion of the other cannot at present be calculated upon. Further, being in the Renaissance style, it shows what might have been made of our our own building at Westminster, had the stipulated-for Elizabethan or Anglo-Renaissance style been adhered to, but at the same time treated with the same freedom and refinement as are shown by MM. Godde and Lesueur, in their *rifacciamento* and enlargement of the Parisian Hotel de Ville. Among the improvements which the structure has received from them, not one of the least is that whereas it before showed only a single front—that towards the Place de la Gréve—it now forms an entirely insulated mass (405 feet by 272), with four regular façades, the original or west one (now greatly extended) towards the aforesaid *Place*, the corresponding or east one towards the Rue Lobau, and of the two shorter ones, that facing the north towards the Rue Tixerandie, and that on the south facing the Quai de la Gréve. So far, if in no other respect, it has greatly the advantage over our Palace of Westminster, one side of which, and that which according to the design is the principal façade, is altogether inaccessible, so that its elaborate decoration, requiring as it does the closest inspection, is completely thrown away.

The former west front, or that towards the *Place*—which was all of the edifice that then showed itself externally—was not quite 200 feet, but is now extended to upwards of twice that length, by the addition of two more lofty pavilions, similar in character, but somewhat varied in design, from the original ones. Hence, the general composition is now increased from three to seven divisions or compartments, two of them being the intermediate *corps de bâtiment* connecting the two pavilions (the old and the new one) on either side of the centre. We may refer our readers to two different views, which they will probably be able to turn to at once, one of them being in Pugin's "Paris," the other in Allom's "France;"* for from them they will immediately perceive how great is the improvement as well as change that has taken place. That façade, however, is not the one which best satisfies us, there being in the original portion of it a good deal in a rather *mesquin* taste, to which the architects were obliged to conform for the rest ; whereas in the three other fronts, and also the inner courts, they have, instead of allowing themselves to be tied down to precedent, given artistic scope to their ideas, seizing on the better spirit of the style by which they were to be guided, and refining upon it by preserving all its really valuable characteristics and *motifs*, and avoiding its uncouthnesses, its harshnesses, and its mere eccentricities. Compared with the other principal front—the eastern one, facing the Rue Lobau—the original one has, in spite of all improvement, a confused, crowded-up look, and shows not a few disagreeable inequalities of taste. The new façades, on the contrary, exhibit not only greater simplicity, but greater richness also. There is infinitely more of homogeneousness of character, the character itself of the style adopted being purged from its littlenesses of manner and other defects. The architects—or perhaps we should say M. Godde,[*] for the other appears to have been only his *adjoint* in the execution of the works—may be said to have given us the ideal of Renaissance—that is, French Renaissance, modified so as to be applicable at the present day.

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* Pugin's representation of the building is so exceedingly poor as to be scarcely intelligible, all the features being so very rudely expressed, that it is impossible to make out more than the mere general design. Allom's, on the contrary, is tastefully touched, and shows as much as can be expected in a general view of the whole front in so small an engraving ; at the same time, there are inaccuracies in it which ought to have been guarded against. That so able an architectural artist as Mr. Allom is, should have given only a single exterior, and not so much as one interior view of so important a public monument, is to be regretted. Perhaps he himself, or his publishers, regret it now that circumstances have given a particular interest to that particular building. Let us hope then, that Mr. A. will visit the French capital once more, and give us a "Paris after the Third Revolution," since he may there find many subjects for his pencil which he had passed over ;—among others, the Church of St. Vincent de Paule, and the Ecole des Beaux Arts, both of which would require to be illustrated by more than one drawing.

Previously to its assuming its present shape and greatly extended dimensions, the Hotel de Ville had only a single inner court—a trapezium in plan, whose eastern side, or that facing the entrance, is considerably wider than the latter. Besides this, which is denominated the "Cour d'Honneur," there are now two other more spacious ones, that on the south side being the "Cour du Prefet," and on the north the "Cour des Bureaux." Yet, in the letter-press account—description it can hardly be called—of the building, in Allom's "France," no notice is taken of this very material enlargement of the plan, but we are left to understand that there is only a single court,—"a spacious (?) quadrangle, entered through the lofty arches in the principal front;" whereas those entrances lead into the two separate new courts. The letter-press writer, the Rev. G. N. Wright, M.A.—don't let us forget the M.A., though it does not mean Master of Architecture,—is one of those ready writers who pay more attention to quantity than quality; for he gives the credit of the present structure to Molinos, an architect who was only employed on some additional constructions to the building in the time of Napoleon, which have since been entirely swept away. He also assures us that all the additions have been made "in the most exact and complete harmony" with the original façade, which, as far as it means anything at all, means that they are little more than a mere copy of it.

Although not very spacious, the inner courts are not the least beautiful parts of the structure; it is, however, easier to judge of their design than their effect, for they are shown only sectionally, whereas subjects of that kind require to be represented perspectively also. For an external façade—more especially if it consist of little more than a single general plane of frontage, without advancing or receding parts—a geometrical elevation may be sufficient; but where several façades or sides—be they those of a room or of a cortile—are seen in combination with each other, the aid of perspective becomes requisite in order to convey an idea of the actual appearance. There ought, in fact, to have been a perspective view also of at least one of the façades, and it should have been of that facing the Rue Lobau, it being the finest of them all, and moreover distinguished from the others by a circumstance that is likely to escape notice in a geometrical drawing, more especially one merely in outline, where there are no shadows to express the various degrees of relief:—the distinction we allude to is that in that front, instead of being engaged ones, the columns of both orders are completely detached from the wall behind, at least along the whole of the central portion of it (extending to fifteen arcaded intercolumns in its length, and having a large and highly-enriched lucarne over each alternate intercolumn).

From the exterior alone, a very imperfect idea is to be obtained of the magnificence of this noble pile of building, which may be one reason for its not having obtained the notice, or anything like the notice, which it may justly claim. Truly palatial in outward appearance, it is equally so within, containing as it does, besides a very great number of various offices and other mere business rooms, no inconsiderable number of state apartments for municipal *réunions* and entertainments, which are not only spacious and handsome, but even truly splendid and sumptuous, and withal afford an unusual variety of scenic effects in architecture. Yet, of all of them, only one, and that by no means the most remarkable of them as a room, is pointed out by the M.A. description-writer in Allom's "France"—namely, the "Salle du Trone," which is in the original portion of the building towards the *Place*.[†] Of the new apartments, nothing whatever is said in that publication; not even the "Galerie des Fêtes" itself is so much as mentioned, although that, and the approaches to it, constitute a group of varied and well-combined architectural beauties, that taken altogether has not its equal in any royal palace of Europe.[*]

To give—what is no easy matter—something like an adequate idea of this part of the interior:—from the lower vestibule is seen extending to the right and left (or north and south) a magnificent staircase, consisting of two wide successive flights of steps, carried in a straightforward direction, between arches supported on marble columns in the upper part of it, where there are galleries or open corridors along its sides. On ascending to the upper landing, a highly enriched dome, though one of moderate dimensions, presents itself; and through this, and three ornamental compartments over the stairs,[†] the staircase is lighted. On looking back from that upper landing, a most striking architectural *coup d'œil* presents itself,—an exceedingly rich perspective vista through an open saloon (the "Salle des Cariatides," over the vestibule below), into the other staircase.[‡] It is, therefore, not without just reason that the staircase is spoken of in the text as a *chef-d'œuvre* of its kind. Even admitting that either of the staircases, in some respects, and among others in spaciousness as to width, yields the palm to the one in the Bibliothek at Munich, the *ensemble* produced by the two greatly surpasses it; for as here managed, it is far more striking than it would have been, had the entire space been thrown open from end to end. In one respect, these staircases have a decided advantage over that at Munich, they being lighted from above, in the manner described,—consequently more picturesquely. Besides which, the Munich one leads architecturally speaking, to nothing, there being merely a number of plain shelved book-rooms, after all the extraordinary parade of approach to them.

Such highly-disappointing falling-off, both with regard to purpose and effect, is most assuredly not experienced in the Hotel de Ville, when on passing from either staircase through a noble ante-room, the "Galerie," with its thirty-two fluted Corinthian columns, profusely enriched pendentives and plafond, and other elaborate decorations, expands itself in all its magnificence. This apartment, which comes in the centre of the Rue Lobau front, is 160 feet by 42, and 40 feet high, with thirteen intercolumns on each side, and three at each end. The cove is divided into arcs-doubleaux and lunettes; of which last, the thirteen on the side facing the windows are open, so as to form a gallery or series of tribunes for spectators, who, through open arches, have a view down into the "Galerie" from the "flat" or roof above the staircases, which space glazed all over, and having pillars along its sides, is thus ingeniously turned to account, and made to produce much novel effect. A similar view is there obtained into the "Salle des Cariatides," through similar openings and the gallery carried around the upper part of that room, to which they afford access. The room just mentioned—which derives its name from eighteen caryatides resting on its cove, so as to form the gallery in its upper part, and support the plafond—comes in between the "Galerie des Fêtes" and the "Salle du Conseil Municipal," as well as between the two staircases; so that from this point—a most happy "*episode*" in the plan—a striking architectural picture presents itself in every direction, whether we look towards the "Salle du Conseil" with the "Cour d'Honneur" beyond it, or towards the "Galerie," or towards either of the staircases. In fact, this part of the plan is eminently replete with piquant complexity—or what seems to be complexity—and variety of effect; and it is all the more striking, because it unexpectedly opens a vista branching out from one side of the "Galerie," and which, therefore, breaks up that excessive sameness of arrangement which, so dull and unartistic in itself, is so prevalent—we might say so uniformly a defect in continental buildings.

There is, besides, a more than usual degree of variety and play in other parts of the plan; for instance, in the several saloons in connection with the "Galerie" at either end of it. One of these bears the name of the "Salon Louis Philippe"—an appellation, that will now, doubtless, be *reformed;* another that of the "Salon Napoleon." Then there is the "Salle des Banquets," respecting which, however, no information is afforded, nor does it show itself in any of the sections; and a grand saloon of reception on the south side of the building, which forms altogether a space of 80 feet by 50, but is so disposed as to assume the appearance of three rooms thrown open to each other by means of three large arches on two opposite sides of the central one. This saloon and the "Galerie" form the subjects of two most exquisitely-elaborate perspective views, replete with a multiplicity of the richest and most delicate details, all rendered with a precision truly marvellous. The other perspectives are, a view of one of the new staircases looking from the upper landing towards the "Salle des Cariatides," and one of the old Staircase as seen from below. There is also a detailed elevation of one end of the "Salle du Trone," showing one of its chimney-pieces and the large caryatid figures, between which is placed the spacious mirror over it. Unfortunately, we are left to desiderate a perspective of the "Salle des Cariatides," which would have been highly welcome, because, although it comes into two several sections, it is on such a scale, that little more than its general architectural design can be made out, and the effect—which is of a peculiar kind—is left to the imagination. Many of the plates are occupied by details and ornaments of both the old and new portion of the edifice, and show how elaborately it is finished up.

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[*] From what is said of him in Nagler's "Kunstler-Lexicon," we find that this architect (who was born in 1781) was employed, among other works, on the restorations of the Cathedral of Ameins; and that while he was Inspecteur en chef de la 2me section des Travaux Public he made plans, elevations, and sections of various churches at Paris, amounting in all to about three hundred drawings; yet whether they were ever published is not stated.

[†] It is mentioned chiefly for the purpose of informing us that it was from the central window, Louis XVI. addressed the people with the cap of Liberty on his head; and Louis Philippe afterwards addressed them, when Lafayette told them, that in him they beheld "the best of all Republics!"—words which the present Revolution and the new Republic will probably verify most disastrously.

[*] After all, such omission on the part of the letter-press was perhaps judicious, because to have spoken of those parts of the interior as they deserved to be, would have been accusing the artist of culpable omission on his part, in not describing any of them with his pencil, more especially as his forte lies in interior subjects.

[†] From the perspective view of the staircase, it appears that these compartments in the vaulting of the ceiling are not exactly what we should call skylights, but ornamental panels filled in with figured glass, either coloured or plain, in the same plane as the other panels. This ought to have been explained in the letter-press, as likewise ought many other particulars with respect to decoration—colour included—which are now left to be conjectured.

[‡] Thus, in regard to mere general disposition of plan, these staircases are somewhat similar to those in our National Gallery, but other resemblance there is none. In all other respects the difference is amazingly great, nor need we say on which side the marked superiority lies.

One important apartment and architectural feature in the building, which we have not yet mentioned, is the "Salle des Elections." This is on the ground-floor, immediately beneath the "Galerie des Fêtes," and of the same dimensions, except that it is somewhat shorter, and, as may be supposed, considerably less lofty. The columns here are of the Doric order, and are brought forward to a greater distance from the walls than in the upper "Galerie." We will now conclude this account—after all, but an imperfect one—by saying, that not only is the edifice itself a most noble and tasteful monumental work, but M. Victor Calliat's publication illustrates it—if not altogether so completely as could be wished—with admirable diligence and taste. We have no English work of the kind that can compete with it, or with the similar splendid one by Joly, on the "Chambre de Deputés" (1840). We have got a Royal Institute of Architects, but architectural publication does not thrive under its fostering auspices. And so wretchedly low is the remuneration of architects in this country, that even those who are most employed cannot afford to risk any of ther earnings in endeavouring to promote architectural study and taste. We can—or rather we *will* only say: *Valdè deflendum est!*

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## ARTS MANUFACTURE EXHIBITION,

### AT THE SOCIETY OF ARTS' ROOMS, ADELPHI.

The Exhibition at the Rooms of the Society of Arts deserves particular notice, because it shows that the workmen of this country have taste and artistic skill, as well as mechanical proficiency. This is the second exhibition of the kind, and it shows very great progress, while it is most remarkable in this very good feature—that whereas before, manufacturers had to be begged and sought to send their works, they have this year sent them freely and with good will. This is going forward in the right path, for it shows that the manufacturers now feel an earnest in the cause, and that gives us another body of yoke-fellows. The artists and workmen have likewise shown their feeling, by the greater care and skill they have bestowed; which is the more pleasing, as it is an encouragement to all those who have come forward in behalf of manufacturing art.

We cannot however help saying, that so much has not been done as ought to have been done in this way, and that still more remains behind. It is pleasing to witness the skill which has been shown; but we are yet far from the goal, and leave foreign nations ahead of us, while we have not means enough to enable us to beat them. We are not yet even with the old Schools of Design in France and the Gewerbe-Instituten of Germany, which we set out to follow, while of late years they have made further way. We call the Central School of Design a mockery; and as for the others, they are only good drawing-schools. The whole is a failure as to quality and extent; and we might just as well think to beat the hosts of Prussians with the Lumber Troop, or set Tom Thumb againt the Spanish giant, as to meet the French, Prussians, Belgians, Swiss, and Italians with the paltry staff we have. Drawing must be taught in all schools to the sons and daughters of working-men; there must be a high school for drawing in every town, and there must be good schools of design in the great seats of manufacture. The buyers at home must be taught as well as the sellers; we must have our people brought up to a knowledge of art, and then we shall be able to go into the markets abroad on a fair footing.

This question of teaching design is one of trade more than of anything else: we were pinched in our pockets before we thought of bestirring ourselves. It was only when we found out how much we were giving to the French for silks, flowers, fancy paper, bronzes, and paper-hangings,—to the Prussians for iron castings and embroidery patterns,—and to the Italians for objects of art, that we began to set up schools for giving our workmen knowledge of design. The tax we pay to foreigners for our lack of knowledge is so great that it would hardly be believed; we spend millions yearly for goods that we ought to be able to make as well: nor does the evil end here, for as we cannot make for ourselves, so neither can we meet the foreigner in the market abroad. This loss falls, too, upon those who have no need of a knowledge of design. Because the French can bring out silks, satins, muslins, cottons, and shawls with better patterns, the English spinner and weaver of plain goods, the machinist, the drysalter, and the merchant, lose a very large share of employment.

It is good that it should be so, that there should be a tie by which all are bound to work, for otherwise there would be no getting any change, for many would give no help to bring it about. Nothing is easier than to show that the machinist, who deals with hard and stiff forms, and who thinks taste is as much beyond as beneath his care,—nothing is easier than to show that even he, working largely for the manufacturers of this country, has a share in the welfare of art. If more silks and cottons, fancy and stained papers, carpets, shawls, furniture, and glass can be sent abroad, more machinery must be wrought for their production. Mr. Fairbairn and his brethren at Manchester, the machinists at Glasgow, at Belfast, and in every manufacturing town, must and ought to know that they have a fellow-feeling in the right growth of the arts of design. If a School of Design be good for anything, it ought to be good for making the trade of the town in which it is greater: it ought not only to better the goods now made, but it ought to enable the town to send out goods such as we now take from the foreigner, or such as we cannot now send abroad. Therefore, we say this has as much to do with the machinist as with any one; but we say that art has to do with all.

Pleased as we were with the Exhibition now open, we cannot but see that what has been done as yet has not carried art down among the people. The works in the Adelphi are either for the higher or middling classes, those who are already cared for—and not for the people. We have always held, from the first time that we undertook to write about it, that art must not only bring forth good works, but cheap works; that it must show itself in the dwelling of the working-man, as well as in the drawing-room of the rich. The earthenware, the glass, the paper-hangings, the furniture in the smallest cot may be as well made as those in the abode of a king,—while taste shown in them will do much more good. If knowledge be power, it is so in the arts as much as in anything else; and we cannot have a people powerful in the art, unless they be well taught. The Society of Arts have the chance of leading in this path—indeed they have given a few prizes; but we call out again, that more ought to be done. Many working men and women and their children will, no doubt, see this Exhibition, but they will go away with the thought that such things are not for them, and that the rich only are happy in being able to glad their eyes with such sights. Thus, the great teaching of the Exhibition will be thrown away; for we hold that working-men will have a greater feeling for the arts of design, as giving a charm to their own dwelling, than as a mere means of livelihood at the will of the rich.

Felix Summerly has taken upon himself a task which is truly worthy in these days; but we want a Felix Summerly for the kitchen as well as the drawing-room: and we hope if he does not take this further task upon him, that some one else will. Mr. Cole, as Felix Summerly, by choosing this path in art, has made himself a good name, as Mr. Hay has by choosing house-painting; and we wish that other men who have taste and skill would follow, and take each some branch in which he can make his artistic knowledge useful. Sir Walter Scott spoke most wisely when he led Mr. Hay to follow house-painting instead of high art; for although Mr. Hay's powers of mind cannot be doubted, we could much better have spared a Landseer or a Wilkie, than one who by his works and his writings has done good to a whole trade, and has taught hundreds of workmen that they may use their heads and eyes as well as their hands.

In the late free-trade speeches in the House of Commons, we were much struck by what Mr. Wilson said, that the only goods sent out in 1847, on which there was no falling off, but which were more in worth, were silks sent to France, a trade which has grown very much, and which some few years ago would hardly have been believed. If we try we can push the French home, but then we must set about it in the right way, not narrow-mindedly as we have hitherto done, but boldly and skilfully. The workman must be as well taught here as he is in France, or he will do no good. We must not have him kept back for fear he should turn out a painter, and come in the way of some Royal Academician hereafter; but we must have him as well taught as the Royal Academician. The groundwork of art is one and the same, whether for a paper-hanger or a weaver, a Landseer or a Gibson; and we believe that often, more taste is shown in a glass jug or in a common shawl, than in the many landscapes and Art-Union paintings which deck the walls of the Royal Academy. So sorrily has the School of Design been managed by the Board of Trade, that we are still no better off than we were eight years ago; nay, we believe that there was a better and a stronger feeling for the arts of design then than now. Since Somerset House lost the spur of the Society for Promoting Practical Design, in Leicester-square, it has gone on but slowly, and it has done nothing for spreading a knowledge of the arts of design among the people.

The Board of Education is as much behind-hand. Though drawing is as useful to the child of a working-man as reading and writing, and though Mr. Wyse has for years brought this before them, masters and mistresses in National and British and Foreign schools know next to nothing of drawing, and do not teach it. The few who do, teach drawing only to a small number of the elder boys, however willing the younger ones or their fathers are that they should learn.

Little or nothing too has been done to teach drawing to girls, so as to fit them to earn a livelihood in many trades where a knowledge of it is of use. When we bethink ourselves how few trades are open to women, we feel how very needful it is that every means should be taken to enable them to earn their own bread; and nothing seems so likely to forward this, as by giving them a kind of knowledge which is so much wanted in England. The trade of flower-making, which is a new one, and in which in 1841 there were a thousand women at work, has now grown very much; but still, many thousand pounds' worth of these flowers, which are better made, are brought over from France.

It is hardly fair to say anything about the Exhibition without speaking of the Catalogue, which will do as much good as the Exhibition itself. It not only tells us what the Society of Arts did last year, and what is shown this year, but it lays down a plan for spreading wider the good the Society is now doing. This plan is two-fold: first, to send round to the country Schools of Design the objects shown in London each year, and thereby to bring it to bear upon the scholars and workmen throughout the country; and second, to have a great show every three or four years, to be held in a building raised at Charing-cross. Altogether, there is such earnest shown to uphold the arts of design, that we feel truly thankful to the Society for the work they have done, and we hope they will have the help of the Board of Trade, and of the Board of Works, in carrying out the two plans. Indeed, the former Board have already made known their goodwill towards it.

There are so many things worthy of being named, that we are almost kept back from saying anything, because we cannot speak of all.

The bronze and iron castings show that we have made way; but we must not hold till we have got beyond the Prussians and the French. The iron castings from Coalbrook Dale, from Messrs. Stewart and Smith, and Mr. Messenger, are very good; and the last has sent some good bronzes, as Mr. Hatfield has likewise done.

Messrs Leighton, the book-binders, have sent a few designs by Luke Limber (John Leighton), and some book-covers in papier-maché, which are very ably done, and show that their trade is not behind-hand. Indeed it is perhaps doing more than others to spread taste among the people.

The carvings in wood by Mr. Jordan's machinery are truly wonderful. They are as good as those of Grinling Gibbons, or of any of his school. There is a freedom about them which shows the hand of a master, rather than of a machine.

Mr. Drayton, it will be seen, has brought forward his new way of silvering glass, by which he can now silver the inside of cups and bowls, plain or carved.

The cartoon decorations by Mr. W. B. Simpson are sure to strike the looker-on, for there is a power in them beyond what has been before seen in decorations. The cartoon of "Loyalty," from Mr. Redgrave's fresco in Westminster Hall, is so good, that it seems the handiwork of a skilful painter; and we can hardly believe that it is not so, for it is so unlike what we see in the generality of decorations.

We think this new process very likely to spread a knowledge of art among the people. There are many places where it can be used, and many joint-stock undertakings which will give it their help. For first-class waiting-rooms in railway stations, for board-rooms, for the counting-houses of banks, assurance companies, and docks, it might be well applied. These great undertakings would, we are sure, willingly lay out a little money in what would please the public, and do credit to themselves. A set of likenesses of engineers would fit a waiting-room well. We would name Watt, Trevithick, the two Stephensons, Brunel, and Locke. Many paintings bearing on trade might be shown, as Mr. Lee finding out the stocking loom; Queen Elizabeth giving a charter to the East India Company; Drake teaching ship-building to Prince Henry in the Tower; the Marquis of Worcester likewise in the Tower making a steam-engine; King William giving a charter to the Bank; the Duke of Bridgewater and Brindley overlooking the works of the Bridgewater canal; Arkwright and the spinning jenny; Watt and Dr. Robison making experiments on the steam-engine; Don Ricardo Trevithick directing the putting together of a steam-engine in Peru; Peel, Huskisson, and George Stephenson witnessing the starting of a locomotive on the Liverpool and Manchester railway. Some of these have been already painted, and there are many other subjects shown in Westminster Hall which might be chosen by Mr. Simpson, as an early English trial by jury, Alfred manning his ships, King John signing Magna Charta.

The inlaid work from Messrs. Holland and Sons shows that in this branch the French and Belgians are not before us, and give hopes that we shall in time drive them out of the furniture trade to America. The taking the duty off foreign woods now allows our cabinet-makers to send goods abroad. The only fault we find is with the centres of some of the tables, which in Nos. 7 and 8 are very ugly.

The copy of an antique shield (No. 10) is a favourable specimen of iron casting.

Nos. 11 and 12 are a very good application of papier-maché to picture frames, by Mr. Bielefield.

The papier-maché cheval screen by Jennens and Bettridge has been got up with great labour. It is called in the Alhambra style and decorated with Arabic inscriptions, but we neither like the style nor the composition. We think the labour misapplied. The colouring of the frame, gold upon a warmish white, looks tame without being rich.

Most of the encaustic tiles by Minton and Co. are dull in colour, which arises from the attempt to apply all colours, instead of sticking to those which do best. Mr. Minton has been happier in glazed tiles. We cannot but wish that the old Flemish glazed chimney-tiles, or something like them, were brought out again. An old chimney-corner, with its set of bible tiles or Flemish landscapes is a story book in itself, and pleasing to old and young. Tiles for walls, with drawings of interesting objects, or with maps, would be welcome in schools and many other buildings.

Mr. Copeland seems a worthy follower of Wedgewood. His works in earthenware are among some of the best in the Exhibition. The taste and care shown in them cannot be gainsaid, and they keep up our fame in this trade, which is worth so much to us. The English earthenware is now the best in the world, and much of it is sent abroad. Indeed, it is a great staple, and worth the more to us as the work and the ware are all our own, only some of the colours being brought from abroad. By the care given to the higher kinds of porcelain, we shall in time be able to put down foreigners in that branch of the trade likewise.

There are so many good works of Mr. Copeland's that we can name very few. An earthenware wash-stand (No. 37) is a very good design. It has a blue ground and white borders tastefully drawn. There are many other jugs and bowls well worthy of praise. The wash-stand No. 88 we do not like so well; its effect would depend wholly on the hangings which might be used in the room. The enamelled porcelain cups and saucers, Nos. 139 and 140, show the resources of the establishment in decoration.

The chimney slabs show the progress which has been made in the application of porcelain and painting for this purpose. The lock-furniture and bell-lever, likewise in porcelain (No. 170), are richly ornamented with gold. Porcelain is now being much used by builders, as is likewise glass for ornamental purposes.

The large collection of works and groups in statuary porcelain shows Mr. Copeland's power in what may be considered a more purely artistic department. This material has been employed by the Art-Union for prizes, and promises to be very useful in spreading a knowledge of the works of our best sculptors, for in effect it comes near marble, and in cheapness near plaster. It takes a middle place between marble and plaster, and being more lasting than the latter, is likely to be very much used by the middle classes. We fear, however, that it will give us in sculpture a school of statuettes, as we have in painting a school of cabinet pictures, and so far draw away the public mind from high art. Still, we welcome the statuary porcelain and the Parian as a good beginning, and we can take the evils when they come with the less remorse, as now sculpture is far from being in the most palmy state. This kind of copy promises likewise a better reward to the artist, for marble is a material costly in itself and hard to work, and therefore the sculptor gets few orders for a good study, and few are fond of casts. Now, a small gallery of groups can be had for a very small sum, and no one need be ashamed of having such works in his drawing-room. Among Mr. Copeland's productions we would notice the Narcissus, after Gibson (No. 209); Innocence, after J. N. Foley (No. 210); Paul and Virginia, after Cumberworth (No. 211); the Return from the Vintage (No. 212); Apollo, after Wyatt (No. 214); Cupid chained (No. 218); and Ondine, after Pradier (No. 219). The busts do not tell so well.

The Cupids holding a Tazza (No. 182) is a very good design for a flower-stand, in statuary porcelain.

Mr. Copeland is very successful in the Portland jug (No. 202), of the same material.

Another work of his we shall name is the Armada bottle (No. 217). We are likewise pleased with this vase after Cellini (No. 223).

Messrs. Chamberlain, of Worcester, have sent some very gorgeous porcelains, gilt, painted, and enamelled.

Mr. Magnus, of the Pimlico Slate Works, has sent slate chimney-slabs, likewise table tops, which are worthy of notice by builders.

Mr. Pratt's Anglo-Etruscan vase, in the Great Room, is very praiseworthy.

The prize candelabrum must be the work of an architectural student, and have been chosen for the prize by an architect. It is what some architects call classical, and what other people call tame, stiff, and bald. We think the prize is thrown away, and we should have been much more pleased with a copy of one of the candelabra in the British Museum.

The prize lamps are not much better. They may catch some eyes, being in silver, but are poor and common-place. We wish there had been more designs for silver-plate. One very good is No. 348, an adaptation of the trumpet lily for a dessert-stand.

The papier-maché productions to our mind show much more splendour than taste. They are too much in the gewgaw and Vauxhall way.

The "Repose" arm-chair (No. 242), is very unluckily named, for there is no repose in its composition, and there can be none within its arms. Mr. J. C. Horsley is the designer, but his skill is quite thrown away, for the reliefs have no effect. The terminal figures, in whatever material they may be finished, will be indistinct.

Mr. Nicholson has shown a very elaborate shell cameo (No. 258), but the subject is too complicated, and therefore indistinct. Miss M. A. Nichols has sent five imitation cameos. Cameo cutting is worthy of care, for in Paris it gives work to many hundred men.

The glass works (Class XII.) are so very good that we hope they are an earnest of our making a great trade in glass, and becoming free from the Bohemians and Germans.

The Decorative Art Society is doing so much good, that we look forward to see some other society raised which shall take in a lower class of workmen. There is room for a great deal to be done, and we feel very strong hope from what we call the small exhibition of the Society of Arts—small because we are sure we shall soon see much larger exhibitions held under its care.

## INDIAN RAILWAYS.

*Indian Railways and their Probable Results, with Maps and an Appendix, containing Statistics of Internal and External Commerce of India.* By an Old Indian Postmaster. Third Edition. London: Newby, 1848.

We are now in 1848, and Indian railways remain where they were, though the East India Railway Company has got a guarantee and leave to begin. This is a hard lesson, but one which is of no good so far as the present is concerned, and will, we fear, be found little better in the future. Governments are not ready scholars, even in the matter of revolutions. We have always upheld the freedom of joint-stock undertakings, as the best safeguard against speculation and the want of it. The East India government were fearful in 1845 of the gambling madness of the times. Scheme after scheme was brought before them, money was held out freely, but they drew back frightened, and set themselves down in what they held to be a quiet and orderly way, to lay down rules on which railways should be carried on and shareholders should pay their money. Following in the path of the Board of Trade here, they sent out to India a railway board, with Mr. Simms at its head. He did his work as well and carefully as he could, and sent home some long blue-books, from which, however, we are sorry to say, we have learned no more than we knew before, so that they have in no way put railways forward one inch. Everything has to be tried still; Mr. Simms has given us no answer as to embankments in the valley of the Ganges, long bridges over the streams, how wood will serve for sleepers, how works are to be carried on, nor one single point in engineering has he settled,—and from no fault of his, because experience is the only guide and judge. Therefore, three years have been lost on this head, and instead of beginning with three or four years' experience, we are as far behind-hand as we were before. It is during the first three or four years that the greatest changes are made, because it is the time of experiments; every day shows something, and instead of trying to settle the engineering of India before-hand, a wise man would wait for practice to guide him in fixing any lasting system.

India has needlessly lost so many years of railway transit; by this time the traffic of the Ganges would have had some small help from railway works. Perhaps a couple of hundred miles of railway would have been open; and if only so much, or even less, still the results would have been great, because each hundred miles of railway is the saving of a day in the communication with the upland. The opening of a railway would have been felt by the steamboats, and more of them would have been put on the river, while branch roads would have been laid down to reach the railway. The making of a railway is, as is well known, only a small part of the good which is to arise. The railway will be the trunk towards which steamboats will run, and roads be made. The traffic will be always growing, so that at each step food for new railways will be found. The steamboats have shown this, though not so much. At first six small steamboats were run, sometime after six more, and latterly six large steamboats have been put on, and there is a call for more. All are paying well, though there is more than four times the power that was in the first instance held needful. We have heard of railway carriages carrying their own railways with them, but it may be said of Indian railways that they will carry their own traffic with them.

When we come to the money part of the question, and say that three years have been lost, we do not give a right idea of the evil which has been done. Time in the share-market cannot be trifled with, and cannot be got back again. The fatal event of Louis Philippe's death or fall has been long hanging over us; it was known that it must happen, and that when it did the share-market would be utterly upset. Never was it so needful to make hay while the sun shone; the storm was hanging about, it was looming in sight, and there was no time to be lost. In the years 1845 and 1846, any money could have been raised; in the years 1847 and 1848, no money can be raised,—and who dares look forward with hope?

If the share-market were as law-makers wish it, and as they have tried to make it, it would be very well; but unhappily it is not so. It does not work so smoothly as they think it may; it has its ebbs and its floods; sometimes setting in with a full tide, whirling and eddying round, the waters rising to the top of the flood, then the stream pouring out with a quick rush and leaving all bare. People were wonder-stricken that there should be gambling in 1846, as if there never were before; and though they were quite ready to say that a heavy fall would follow, they did none the more wisely. Time has shown that while share-gambling is going on, railway-making is going on; and when share-gambling is at an end, money cannot be raised even for the most useful undertakings. There is a cloud hangs over all, the good and the bad; and though those who have helped to make the storm worse may wish it otherwise, the good feel it as much as the bad.

While the share-market flourished, and the East India government were besought to give their leave for the railways to be begun, they stopped short, as if they had time in their own hands, and could wait as long as they pleased. They have so often set up kings in the east and put them down—they so often send out their word, and a mighty kingdom springs up or is cast down, that they thought they had only to speak, and railways would be made whenever they liked. Had they then, as they were told, given the lines without guarantees, the money would have been raised; whereas now, even with a guarantee, the undertakings linger, and, as we have said, how long they may linger no one knows. The share-market when once shaken does not recover at a fixed date; it is not within the power of any one to know when it will recover, while the shock is now very great. The banks throughout Europe are breaking, the hoarding of gold and of silver has begun, money will go out of sight, war may spring up, the government may give as formerly six or seven per cent. for loans, and then the common returns of joint-stock undertakings do not hold out hope enough to the shareholder or lender.

By the blundering of the government has the welfare of India been threatened, and it is only by acting otherwise than they have done, that they can stop the evil from spreading further. India has felt a great loss in the want of railways, but if she is to be kept without them for years, the mischief which will be done will be great. India has to struggle in trade with America and the West Indies, where railways and steamboats are widely spread; and unless India have the same help, she cannot keep up in trade against them. India can raise cheaply—none can beat her; but so much time and so much money is spent in carrying goods to market, that they come dear and bad, instead of cheap and good.

It will do little for India that English gold is now not likely to be sent abroad to France, Flanders, Italy, and Spain for railways; shareholders are sick of them, and will be afraid to have any thing more to do with them. This is however no help, we fear, for India, for the call for money at home cannot be met, as so much has been lost.

Among the undertakings which were brought into the market in 1845, none hardly were more useful than that of the East India Railway Company, for making a railway from Calcutta for 800 miles up the valley of the Ganges. Mr. Macdonald Stephenson, its managing director, gathered together all that could be learned in India, and in his works gave the heads of what Mr. Simms has written since. There was quite enough to show the likelihood of the undertaking, and when it was brought forward it was hailed by the leaders of the money market as a railway well worthy of their help. The heads of the East India Railway Company were some of the richest merchants here, and there was such trust given to it that its shares rose very quickly in price.

Thanks to the Board of Trade, the Company was withheld from taking more than five shillings a share when they could have had two pounds; so that now, instead of having some hundreds of thousands of pounds in hand, enough to make a good beginning, they have hard work to raise a hundred thousand pounds, which is to be lodged with the East India Company.

The East India Company has in the end given to the Railway Company leave to go on, and offered a guarantee of interest, which in 1845 or 1846 would have sent up the shares to such a price as to have made them among the best in the market. There were then no shares in the market guaranteed by any of the English governments, and such was the call for guaranteed shares that those guaranteed by the great railway companies were eagerly sought. Therefore the market was clear for the Indian railway shares, and nothing but the utter blindness of the government kept India back at such a time. On what good grounds it could have been done no one can readily see, for India is always in want of money, and when there was a hope of getting it from England it should not have been let slip.

We have still the utmost trust in the East India Railway Company, for we believe that the line must be made, and we hope therefore that everything will be done at once to help it on. We see no good in leaving a hundred thousand pounds in the hands of the government, that should be dropped at once. The Company should likewise have full power to borrow money here and in India, in whatever way they can. If there be any need of it, the government of India must lend them money to begin, so that they make a start, for there is no time to be lost. If there should be a war in Europe, and the overland way to India be stopped or hindered, then it will be still more needful that there should be a quick transit between Calcutta and the north-west.

On these grounds we say to the East India Railway Company "Hold on;" for if the government do their share, the undertaking will become one of the first in the world. Much of the railway can be readily made, and as cheaply as those of America, while it has only to be opened to have a good income at once. We have always believed, and we do still, that when a start is made, a great deal of money will be got from India: India finds money for banks, assurance companies, steamboats, coal mines, indigo works, sugar mills, and tea plantations, and we do not see why she should not for railways. The Indian mind is awakened. What has been seen of late years has laid the way for railways. The steamboat has shown the Hindoos that speed can be got, that goods can be brought up quickly, and they are ready to believe that railways will do for them what it has been held out they can do. India waits only for a beginning, and then railways will spread as many arms over the land as they have in England or America.

In Southern India the companies are still less ready to begin work, so much have they been weakened by the loitering of the stand-still government, but as railways are fully as needful there as in Bengal, we hope very little time will run before steps are taken to bring them forward. The growth of cotton in Bombay and Madras is kept back by the want of railways, and a little help only will enable the merchants and people of those two presidencies to make their own railways. They have come forward most warmly, and although their late losses have lessened their means, they will be found ready to follow up the lead of the government.

Railways in India must be made, and they must be carried out as joint-stock undertakings; for whatever may be the want of power of these latter now, the government in India are no stronger, and always find it hard to raise money. Let us hope, as so much blame belongs to them for the hindrances they have hitherto thrown in the way of railways, that they will see good to make a change, and do all they can to make up for lost time. If they do not do it of themselves, the parliament of England must do it for them; for if the cotton-growers of India cannot be heard there, they will be heard here, and the cotton-weavers of Manchester have already spoken out. We cannot be left in the power of America for the cotton, on which our great staple manufacture depends, and whereby so many Englishmen earn their scanty livelihood.

The third edition of the book before us is on the same plan as those that went before it. It is enlarged by some new extracts, which are put together without any great regard to order, and the staple is still from the works of Mr. Macdonald Stephenson. The right title would be "Indian Railways from the works of Mr. Macdonald Stephenson, with other matter by an Old Indian Postmaster." Except Mr. Stephenson's materials, the best thing in the book is a map of the lines of railway in Northern India.

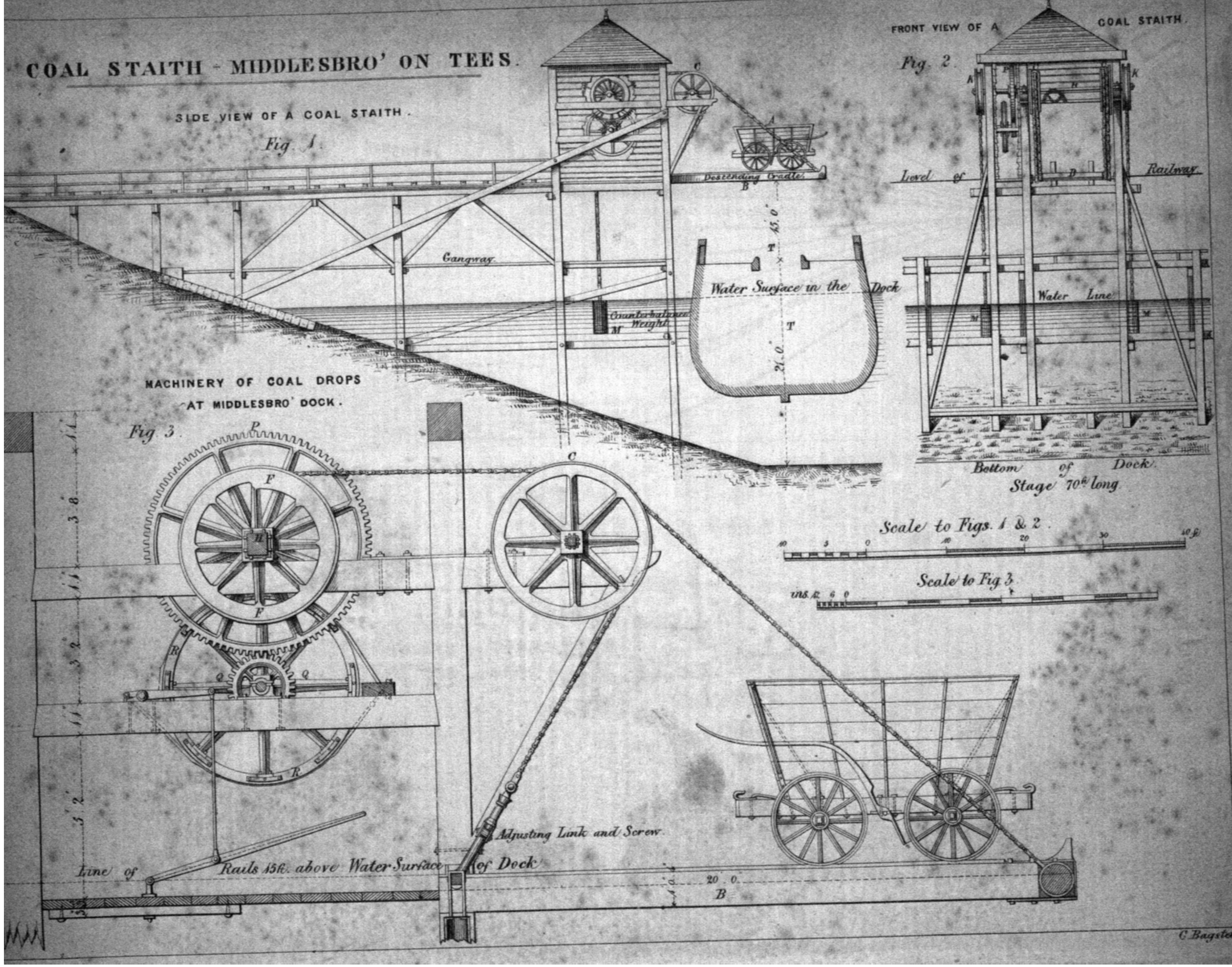
## THE WICKSTEED ENGINE.

Mr. Wicksteed was the first to introduce the Cornish engine into the metropolis, and he deserves great credit for his exertions. The first engine was put up about four years ago, when a description of it was published in this *Journal*. The second, which is larger, is named the Wicksteed engine, and is erected at the East London Water Works. It was started to supply water to that company's district in June 1847, and is the largest engine hitherto erected in London; it was designed by Mr. Wicksteed, who is engineer to the company, and was erected under his superintendence. It was manufactured by Messrs. Sandys, Carne, and Vivian, of the Copperhouse Foundry, Hayle, Cornwall. The diameter of the cylinder is 90 inches, the diameter of the pump 44 inches, length of stroke 11 feet, and it pumps 20 imperial barrels at each stroke. When working at the rate of eight strokes per minute, it raises 5,792 gallons per minute, or 8,340,480 gallons per diem, or 84,563,200 imperial barrels per annum. The power when working at this speed is 200 horse-power. The main beam is 39 feet long, and weighs 33 tons—it vibrates on a cast-iron main gudgeon 16 inches diameter, and the whole is supported by four columns and an entablature of cast-iron, designed in the Grecian-Doric style. The plunger with its appendages weighs 43 tons, which mass of matter is raised 11 feet high at each stroke of the engine. The pump-work is supported by two iron girders weighing each 10 tons, and is strongly bolted down to a mass of masonry in the foundations. The boilers, four in number, are cylindrical, 34 feet long, 6 ft. 6 in. diameter, with an internal fire-tube four feet in diameter. The diameter of the steam-pipe is 16 inches.

The total weight of the engines, pump-work, and boilers is 414 tons, and the whole cost was £10,000, or £50 per horse-power, or about £24 per ton.

The quantity of coal consumed by this engine, if working at full power night and day, would be 2,000 tons per annum, and the quantity of coals that would be consumed by the best of the ordinary non-expansive engines in doing the same work would be 4,500 tons; showing a saving in favour of the Cornish engine of 2,500 tons, which at 13*s*. per ton is £1,625 per annum, or $16\frac{1}{4}$ per cent. upon the cost of the engine for coals only.

# COAL STAITH - MIDDLESBRO' ON TEES.



## COAL DROPS, AND MIDDLESBOROUGH DOCK.

*(With Engravings, Plate VI.)*

*Account of the Drops used for the shipment of Coals at Middlesbro'-on-Tees, with a description of the Middlesbro' Dock.* By George Turnbull, M. Inst. C. E.—(From a paper read at the Institution of Civil Engineers.)

The dock was commenced in the spring of 1840, and was opened for trade on the 12th May, 1842. The general form of the dock and its position with respect to the river Tees will best be understood by reference to the annexed engraving. It possesses an area of 9 acres at the water surface; the approach is by an entrance channel, rather more than a quarter of a mile in length, cut through the sand banks of the river, and kept open by means of occasional sluicing from the lock-gates, and also through culverts built in the lock walls for that purpose. Some apprehensions were entertained of the practicability of keeping open the entrance channel by these means, as there is much shifting sand in the bed of the river Tees, and every interference with the current of the river produces marked alterations in the form and position of the shoals or sand banks. After due deliberation, the scheme was at length carried into execution, under the sanction of the Tees Navigation Company, and the result has been marked with the complete success which was anticipated by the projectors; the channel was dredged out to its full depth, the slopes and banks were covered with a paving of rough chalk and stone, and after a trial of nearly three years the channel is now in a better state than when it was first made, and is kept up at a very trifling cost.

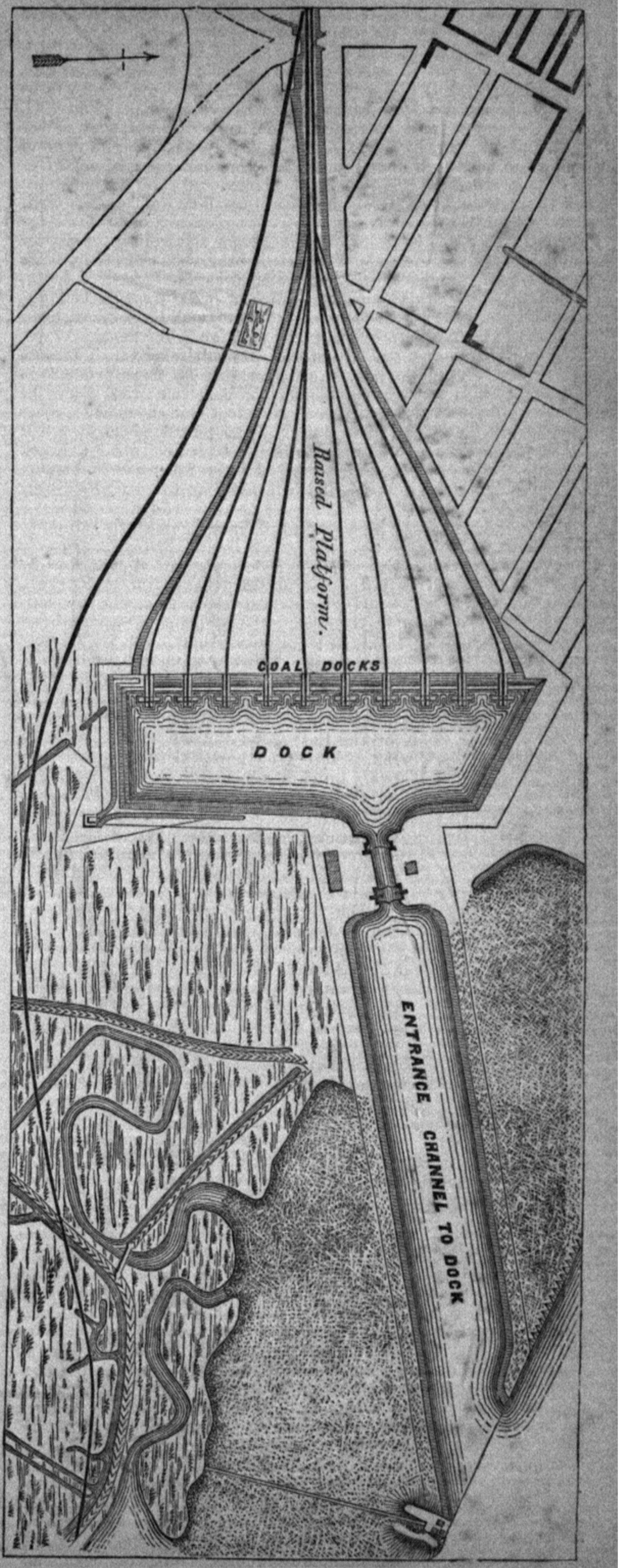
The entrance lock is built principally on a foundation of hard sand, and on account of the quantity of water found in it, an unusually large proportion of piling and wooden platforms were required in the foundations. The lock is built of stone, chiefly from the Byker quarries, on the river Tyne; it is 132 feet long and 30 feet wide; the depth of water is 15 feet at neap tides and 19 feet at spring tides: the bottom of the dock was excavated to the depth of 3 feet under the level of the lock cills.

In connection with the dock, a branch line was laid down, diverging from the Stockton and Darlington Railway and terminating in ten double lines, leading to the ten drops (1 to 10) situated on the west side of the dock. The raised platform of a triangular shape, covered by these diverging lines of railway, comprises an area of 15 acres, and affords spare room for 1,200 loaded wagons, or more than 3,000 tons of coal, besides means of egress for the locomotives with their trains of empty wagons. This great amount of standing room forms a principal feature in the arrangement of these works, as in the district, of which this is the shipping port, there are numerous descriptions of coal, several of which come down the railway in the same train; a separation is made on the platform, and each colliery having its own drop assigned to it, the wagons, with the proper description of coal, accumulate in one branch, and descending along the railway, which is so inclined as to permit the wagons to move by their own gravity, the shipment is carried on with much facility. An inclination in the contrary direction is given to the empty line, sufficient to allow the unloaded wagons to move of themselves, by which means some saving of horse labour is effected.

The cost of all the works connected with the dock, including the branch railway, raised platform, permanent rails, dock work, entrance lock and channel, and breastworks along the shore of the river Tees, with the ten coal drops, amounted to the sum of £122,000.

These works were designed by Mr. W. Cubitt, V. P., and the author was the acting or resident engineer.

The coal drops are peculiar in their construction and are probably not much known beyond the district in which they are used; they are distinguished from the drops in common use on the Tyne, by the coal wagons being lowered perpendicularly to the ships' decks, whereas in the latter the wagons are lowered by means of a cradle and vibrating frame, which describes the arc of a circle in its descent. In places where the wagons have to be lowered from a height of 30 feet and upwards to the ships' decks, which is a common circumstance in the Tyne and the Wear, the vibrating frame (originally invented by the late William Chapman of Newcastle) are found well adapted for the purpose; but where the height is limited, or where the railway is so low that the wagons are just clear of the taffrail of the light ships, the perpendicular drop becomes more convenient. This ingenious contrivance was first suggested to the Clarence Railway Company by Mr. George Leather, of Leeds (M. Inst. C. E.), and was carried into effect at



Port Clarence on the river Tees, where several of them have been in use for some years, and are very effective.

The ten drops erected on the west side of the Middlesbro' Dock are almost similar, in every respect, to those at Port Clarence. The principle of their construction and mode of operation will be readily understood by a reference to the engravings, Plate VII. Fig. 1 shows a front elevation, and fig. 2 a side elevation of the drop and its machinery; fig. 3 shows the machinery, with the cradle and wagon, drawn to a larger scale; the same letters refer to the same parts in the different drawings.

The wagon A, weighing about 30 cwt., and containing one chaldron or 53 cwt. of coal, is shown standing on the moveable stage or cradle B, which is suspended by means of chains passing over the sheaves C, C; the ends of the chains are attached to the large sheaves F, F, the latter being cast with grooves of unequal depth, to accommodate the two chains, which it will be seen are of unequal length, and require a corresponding inequality in the sheaves, to preserve the cradle in a horizontal position. These sheaves are fixed on a strong iron axle H, on the extremities of which are two other sheaves or pulleys K, K, to take the chains which sustain the counterbalance weights M, M. The break machinery for lowering the wagons consists of the toothed wheel P, 7 feet diameter, fixed on the same axle H; the pinion-wheel Q, 2 feet diameter; and the break-wheel R, 6 feet diameter, having a break over its whole circumference, worked by a strong lever-handle, which controls the descent of the loaded wagon, and its ascent when empty.

When the machinery is at work, the loaded wagon is run on to the cradle, or stage, B, and is stopped by wooden chocks in its proper position, directly over the hatchway of the vessel to be loaded (T, T, fig. 1.) The breaksman then releases the break-wheel, when the cradle and wagon descend perpendicularly, the suspending chains winding off the sheaves F, F, the counterbalance weights rise, and their suspending chains wind on to the sheaves or pulleys K, K. The cradle, with the wagon upon it, still maintaining its horizontal position, having nearly reached the ship's deck, the contents are discharged by a man who descends with it for that purpose; the counterbalance weights then have the preponderance and the operation is reversed, by the weights descending and the empty wagon and cradle rising to their original position. The whole is so guided and controlled by the breaksman, and the counterpoise weight so adjusted, that the wagon can be made to descend and ascend quickly or slowly, or be stopped with ease in any position, either ascending or descending.

The drops at Middlesbro' Dock are constructed of strong wooden framework fixed on Memel fir piles, and the cost of the ten drops was £7,300, or £730 each, including all the timber, iron-work, machinery, and the labour in fixing.

Each of these drops can ship a wagon load of 53 cwt. in a minute, or about 150 tons in an hour; but as the coals cannot be trimmed off so quickly in the ship's hold, about thirty wagons an hour may be taken as the ordinary rate of working. Forty wagons, containing a chaldron each, which are = 5 keels or 106 tons an hour, may be considered the limit of working.

In the year ending 1st July, 1845, 505,486 tons were shipped by means of the ten drops here described. The shipment in the six months ending 31st December, 1845, amounted to 264,180 tons.

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## ON THE RESISTANCE TO BODIES IN FLUIDS.

*On the relation between the Velocity and the Resistance encountered by bodies moving in Fluids.* By John Mortimer Heppel, Grad. Inst. C.E.—(Read at the Institution of Civil Engineers.)

The determination of the relation between the velocity and the resistance encountered by bodies moving in fluids, has always been an interesting topic of inquiry, as well to the speculative philosopher as to the practical mechanist, and perhaps on no portion of physical science have more pains been spent; whether looking to the sagacity with which experiments have been devised, the liberality with which they have been carried out, or the mathematical acumen with which their results have been classified and brought under general laws. To enumerate the names only of the men, illustrious by their science, who have brought their energies to bear on this subject, would fill a larger space than these few remarks are intended to occupy. It is sufficient to mention Newton, who in this, as in so many other departments of philosophy, first shed the light of his brilliant genius on the former obscurity;—after him the scarcely less celebrated Daniel Bernouilli, and in latter times Bossut and De Buat, whose patience and accurate research opened such a multitude of observed facts to the contemplation of the theorist. Again, the valuable experiments of the French Academicians; the indefatigable labours of the late Colonel Beaufoy, so liberally made available for the objects of science by his son; and lastly, though not among the least, must be mentioned the excellent experiments on canal boats by Palmer and Macneill, given in the Transactions of the Institution (vol. I. pp. 165-237). After such a retrospect it may appear presumptuous in a young and unknown individual, attempting to add anything to a subject already enriched by such contributors; as his remarks, however, are brought in an humble and modest spirit, and so far as he is aware, have not been anticipated by any precisely similar, he begs to lay them, without further introduction, before the Institution.

It will no doubt be recollected, that in the cases already glanced at, the almost invariable method of experimenting has been to attach a weight, or other known motive force, to the body in question, and to determine, by direct observation, the quantity of this, corresponding to an uniform velocity of progression. From this method it has necessarily followed, in most instances, that the bodies subjected to experiment were of moderate dimensions, and the theoretical views derived from the observations, have been extended to those which from their magnitude have been placed beyond the range of direct experiment. In the experiments of Palmer and Macneill, the same mode of proceeding was adopted, by applying the dynamometer to boats moving on canals, and from the magnitude of the scale of these experiments, as well as from the care and accuracy with which they appear to have been conducted, they must be very valuable. Gigantic, however, as these bodies were, as compared with those which had previously been brought under investigation, they become dwarfs in respect of the vessels, the knowledge of whose properties is every day becoming a matter of deeper practical importance. It has often surprised the author, that these vessels themselves had not been made the object of experiments, with reference to this question, and more especially, if it can be shown, as is here attempted, that those propelled by steam, more especially, unite all the conditions requisite for obtaining easily and simply, accurate and important results. The form, however, of these experiments, must differ from that of former ones, as the tractive power requisite to maintain a high velocity, in such large bodies, would be far greater than could be conveniently disposed for such a purpose.

There is, however, another no less certain mode of inferring the amount of resistance encountered by a body, which is, to remark the diminution of velocity produced in a given small portion of time, when the body is exposed to the action of this resistance alone, from which diminution of velocity, the force which produced it may be inferred with mathematical precision. Let it be presumed, in the first instance, that the velocity with which the vessel is at any instant moving through the water, is capable of being measured and observed; then having set the vessel in motion, with a given velocity, let the action of the motive power be stopped. The only forces to whose action it will then be exposed, are the resistance of the water and the air, of which the former will be by far the more considerable; but of both of which it will always, under ordinary circumstances, at the same velocity, have the same amount to encounter, and whose amount therefore constitutes the obstacle to be overcome by the motive power, and determines the quantity of that power always required to maintain that velocity. From the instant when the engines are stopped, the speed of the vesssel will obviously diminish, and let the amount of its diminution during some small interval of time, say a second, be noted; that is to say, the difference between the velocity at the commencement and at the end of that interval. Now if the vessel had been subjected to the action of a force equal to its whole weight, the amount of velocity destroyed in a second would have been 32 feet per second, therefore, as 32 feet is to the observed loss of velocity in feet per second, so is the whole weight of the vessel, as shown by its displacement, to the force by which this loss of velocity has been produced; that is, to the united resistance of the water and the air, corresponding to the velocity in question. It is here assumed, that the force of resistance, for the small period of the observation, may be regarded as uniform; a supposition which is not precisely true, as the resistance diminishes with the velocity; the smaller, however, the interval of time which is taken, the nearer will this supposition be to the truth, and if the inferred resistance be taken to correspond neither to the initial nor the final velocities, but to their mean, the error will become infinitesimal. A more important source of error would be found in the circumstance of the resistance of the paddles, or the screw, where they are arranged so as to be disconnected, being included in the determined resistance; and in these cases, this would have to be allowed for and be deducted. As however the resistance to flat surfaces has been so fully investigated, this would occasion little difficulty. An example perhaps will serve better to render the foregoing proposition clear. Suppose a vessel to be going through the water with a velocity of 15 feet per second, and on the stopping of the engines, the speed be observed in one second to sink to $14\frac{1}{2}$ feet per second, the velocity destroyed in one second of time would be equal to 6 inches; this is $\frac{1}{64}$th part of the velocity which would have been destroyed, in the same time, by a force equal to the weight of the vessel, and the force which destroyed it is therefore equal to $\frac{1}{64}$th part of that weight. Now suppose this, as ascertained from the displacement, to be 1,000 tons, then the mean force of resistance between the velocities of 15 feet and $14\frac{1}{2}$ feet per second is $\frac{1000}{64}$ tons, and the power expended in overcoming this resistance, at the mean between the two velocities, or $14\frac{3}{4}$ feet per second, is—

$$\frac{1000 \times 2240}{64 \times 550} = 63{,}36 \text{ H.P.}$$

Having thus described the mode in which the observation should be conducted, it may not be uninteresting briefly to notice the advantages which might result from a well-arranged set of experiments on this plan.

In the first place, it would offer an infallible means of testing the qualities of any particular vessel, apart from those of her machinery; since the action of the engines being stopped during the observation, has clearly no influence whatever on the rate of diminution of the velocity. The observer would thus, in case of any deficiency of speed, be enabled to fix the fault with certainty upon the vessel, or the engines, as the case might be. Indeed, if all vessels were submitted to the observation here described, there seems to be no reason why their resistance should not be as precise and definite a quantity, and as capable of accurate expression for any particular draught, as their displacement; and it might be confidently asserted, that the vessel which in this way showed the least resistance, ought to beat all others *cæteris paribus*, and if she were not found to do so, that the fault was either in the engines, or in the propelling apparatus, and certainly not in the ship.

This however, though one advantage, would not be the only one, as a series of observations made upon the same vessel, at various velocities, could hardly fail to demonstrate some expression or law of relation, between the observed velocities and the resistances, which if found to be uniform within the limits of the experiment, might fairly be presumed to extend to some distance beyond them, so that there would be a strong ground for predicting, with confidence, the increase of speed which might be expected to result from any proposed increase of power.

Again, if these observations were repeated for various draughts of water, in the same vessel, the means would be furnished of knowing, *à priori*, the precise amount of power which should be necessary for maintaining a given speed, with any required load. Or if the power remained constant, what would be the speeds which should correspond to various loads, and as before, if the performance of the vessel should fall short of what had been so determined, the fault would be in the machinery.

It may be mentioned, that although hitherto no opportunity has been afforded for testing the correctness of the views here propounded, by a practical application of them to the point in question, yet the author has on several occasions adopted a method, similar in principle, in determining the resistance of shafting and machinery, by observing the rate of diminution of the velocity, on shutting off the steam from the engine, and having had good reason for believing the results, in these cases, to have been tolerably accurate, in spite of the difficulty of correctly estimating the aggregate momentum of so many bodies revolving at various velocities, he is encouraged to suppose, that in the case of a floating body, whose momentum is so easily and precisely ascertainable, the result would be more exact and unquestionable.

The method adopted by M. de Pambour, for ascertaining the amount of resistance to the motion of railway trains, by the circumstances attending their descent and stoppage upon two consecutive inclined planes, is based upon precisely the same principle as that here advanced.

It remains only to consider, by what means the variable velocity of the vessel can be measured, so as to ascertain it, at any instant, with the necessary precision. In the absence of a better, the following arrangement might perhaps be adopted with advantage:—

To the bowsprit of the vessel (Fig. 1), sufficiently a-head to be beyond the disturbed water, should be screwed a small iron bracket, carrying a pin, which should pass through a hole in a slender rod, hanging down below the surface of the water, and prolonged a few inches upwards above the bracket. Upon this rod, a metal sphere should be fitted, so as to be fixed at any required distance from the point of suspension; from the upper extremity of the rod, a small cord or wire should be brought, passing to some convenient spot on the fore-part of the deck, where it should be attached to one arm of a rectangular lever, whose other arm or index should move along an arc of metal.

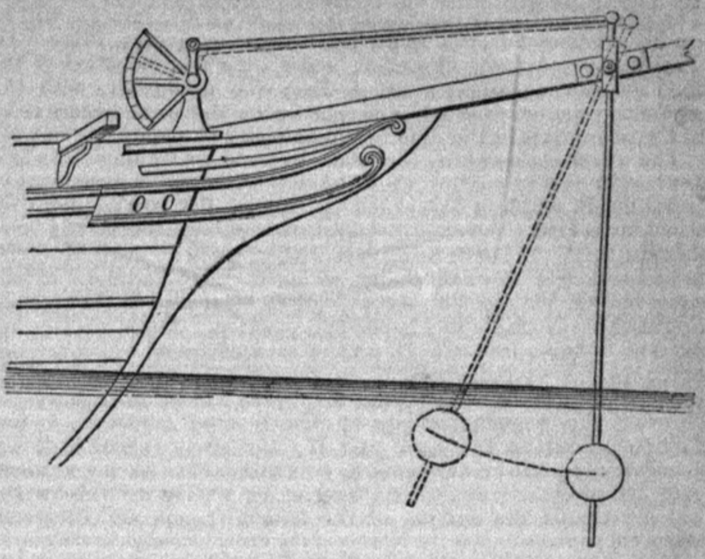

Fig. 1.

It will be clear, that when the vessel is at rest in the water, the rod, with the sphere attached, will hang vertically, and the cord being properly adjusted, the index of the bent lever will be horizontal, at which position the zero of the graduated arc should be marked. If the vessel moves through the water, the resistance on the sphere will throw the rod out of the perpendicular, as indicated by the dotted line, and the angle which it makes with its former position, will be shown by the new position of the index on the metal arc. It is obvious, therefore, that the same degree of deflection will always be produced by the same resistance, and the same resistance by the same velocity. So that if the arc has once been carefully graduated, by moving with known velocities, which would have to be done once for all, it would always afterwards furnish a correct indication of the velocity with which the sphere, and consequently the vessel, was moving through the water, at the instant of observation. A slight consideration of the nature of this apparatus in action, will make it apparent that the position of the ball, or sphere, on the rod is indifferent, and that the same angular deflection will always correspond to the same resistance. This would contribute to render the arrangement convenient as being applicable to vessels of various heights.

The mode of using this apparatus is obvious; an observer, with a seconds watch, would note the positions of the index on the arc, at such intervals of time as should be determined upon, when the diminution of velocity and consequently the retarding forces would become known, as before described.

Mathematical expressions have in the course of this paper been expressly abstained from, as being unnecessary to a general view of the method proposed. It may however not be out of place to remark, that perhaps the best way of treating the observations when obtained, would be to endeavour to discover an expression, representing accurately the velocity in terms of the time, in which case, its differential co-efficient would be accurately proportional to the resistance.

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### *Remarks made at the Meeting after the reading of the above Paper.*

Mr. **Scott Russell** said he could not venture, without more careful consideration of the subject than was permitted by merely hearing the paper read, to draw any comparison between the results stated by the author and those which he had arrived at from the extensive series of experiments he had made; but his first impression was, that the method proposed was not the most direct, and that it was liable to several objections. He doubted whether there was a sufficient knowledge of the resistance of flat bodies moving through fluids, to enable the portion of resistance due to the floats of the paddle-wheels, in a state of rest, to be separated, in the general result, from the resistance due to the body of the vessel. Assuming such to be the case, he must contend, that unless some means existed of raising the paddle-wheels out of the water, simultaneously with stopping the engines, an accurate result could not be arrived at. The screw propeller offered greater facilities, as he believed methods had been devised for raising it out of the water. He was of opinion also, that unless the experiments were tried in perfectly smooth water, they could not give accurate results, on account of the dipping of the bow of the vessel, and the consequent oscillation of the suspended sphere and rod, which would become a pendulum. These were practical objections, which were raised in his mind, by the difficulties he had experienced, in determining the method of conducting his own experiments, which were all tried upon vessels of considerable bulk and tonnage. The mode he eventually adopted was, to try the vessel both light and loaded. First taking all the float-boards off the paddle-wheels, and by means of a steam-tug, of about 250 h.p., drawing the vessel through the water, ascertaining the resistance at different velocities by means of a dynamometer; then, by replacing the float-boards, varying the load, and consequently, the immersed section of the vessel, and noting carefully all the results, he found an extraordinary uniformity in the amount of resistance by similar forms at equal speeds. At first he conceived, that it would have been necessary to reduce all the oscillations of the dynamometer, but he found the motion was so uniform, that any ordinary instrument would suffice for the purpose. He used an instrument, called Pitot's tube, for measuring the velocity, and he had found it very valuable; he might say almost unerring. It consisted of a vertical glass tube placed in the centre of the vessel, through the bottom of which a hole of about half an inch diameter was bored, to pass a metal tube, continuing for a distance horizontally beside the keel, and terminating in a funnel-shaped mouth. When the vessel was at rest, the water outside, and the column within the tube, stood at the same level; but in proportion as the velocity of the vessel increased, so the column of water in the tube rose; and by graduating the tube in accordance with observed heights for given speeds, the results might be read off with great facility and accuracy. Any undue amount of oscillation was prevented, by contracting the area of the metal tube at one spot, by a stop cock, which was only opened when taking observations. He thought the method he had described, combined with the use of Pitot's tube, was preferable to that proposed by Mr. Heppel.

Mr. Rennie concurred with Mr. Russell in his opinion of the proposed method of experimenting. No subject was more difficult than the resistance of fluids. It had occupied the attention of the most learned philosophers, yet nevertheless the present state of knowledge of the subject was still very imperfect. The true theory had never been discovered. Newton to whom, after Galileo, the credit of the first precise experiments was due, had also given the first of the two theories, of which the least imperfect supposed the body to be directly struck by each of the molecules in motion. The subsequent experiments of Bernouilli, Euler, Robins, Borda, Bossut, De Buat, and others, had shown the imperfection of that theory.

The experiments of the French Academy, and the labours of Bouguet, Clairbois, Duhamel, Don Juan, Chapman, Forfait, Attwood, Dupuis, Poisson, and others,[1] had shed considerable light on the subject, and on that of the stability of floating bodies; but no extended series of experiments was tried in this country, until the question was taken up by Colonel Beaufoy, who in 1791 established a "Society for the Improvement of Naval Architecture," under whose auspices he made, in the Greenland Dock, the elaborate experiments, the first portion of which had been so munificently presented to the scientific world by Mr. Henry Beaufoy.[2] The society however sunk for want of funds, and the experiments were eventually conducted and brought to a conclusion, entirely at the expense of Colonel Beaufoy. A short notice of them in Thomson's "Annals of Philosophy"[3] induced the communication of the results of a similar series of experiments, made by Messrs. Lagerhjelm, Forselles, and Kallstenius for the Society of Ironmasters of Stockholm, at the Fahlun mine, between 1811 and 1815. Owing to the combined circumstances of the Swedish language being but little cultivated in England, and a want of mathematical attainments in those who did understand the language, the Swedish experiments remained untranslated, until after Colonel Beaufoy's decease. Mr. Henry Beaufoy then committed the book to the Rev. Elijah Smith, of Sidney College, Cambridge, who learned Swedish and completed the translation, as also that of Lagerhjelm's "Testamen Theoriæ Resistentiæ Fluidorum constituendæ." The results of these examinations occupied ten years in their reduction, and yet but few practical results had been obtained. The general deductions which appeared to be drawn were—

1st. The confirmation of the theory, that the resistance of fluids to passing bodies was as the squares of the velocities.

2ndly. That, contrary to the received opinion, a cone would move through the water with much less resistance with its apex foremost, than with its base forward.

3rdly. That the increasing the length of a solid, of almost any form, by the addition of a cylinder in the middle, diminished the resistance with which it moved, provided the weight in the water remained the same.

4thly. That the greatest breadth of the moving body should be placed at the distance of two-fifths of the whole length, from the bow, when applied to the ordinary forms in naval architecture.

5thly. That the bottom of a floating solid should be made triangular; as in that case it would meet with the least resistance when moving in the direction of its longest axis, and with the greatest resistance when moving with its broadside foremost.

Such was a short summary of the labours of Colonel Beaufoy, to whom the scientific world was deeply indebted. Mr. Rennie thought, however, that errors had been fallen into, by not sufficiently considering the question of the friction upon the sides of the various forms used in the experiments. They were moreover tried upon masses of too small dimensions.

The papers on the same subject in the archives of the Institution of Civil Engineers, presented by Bidder, Carlsund, Telford, Palmer, and Macneill, and those of Fairbairn and Colonel Page,[4] treated of experiments upon larger vessels, and produced more practical results.

The great difficulty of separating the resistance from the friction, arose out of the imperfect apparatus hitherto adopted. The balance of Coulombe, and the pendulum, had been tried with doubtful success. Profiting by the problem of the cylinder revolving in the vortex, in the Principia of Newton, Mr. Rennie undertook a series of experiments in the year 1830, which were published in the Transactions of the Royal Society, "On the Resistances of solid Bodies in Air and Water."[5] The apparatus consisted of an upright spindle of wrought iron, made to slide up and down in a frame, so as to be plunged to any convenient depth in the water, or to revolve in air only, as required.

The iron discs of square, circular, and triangular forms, as well as the cylinders and globular bodies, all of the same areas, were moved through the same spaces, and with the same velocities, in air and in water; the results were tabulated, and the conclusions arrived at were:—

1st. That the friction and adhesion were not as the surfaces, with slow velocities; being in the ratio of 1 to 3, and diminishing rapidly with the velocities, without observing any ratio.

2ndly. That the resistance of fans and globes of equal areas in air, was as the squares of the velocities up to 8 miles per hour.

3rdly. That the resistance of fans or discs with equal areas, was to globes as 2 to 1.

4thly. That the resistance of fans or discs to globes of equal area in water, was to the globes as the squares of the velocities.

5thly. That the mean resistance—

| | |
|---|---|
| Of Circular discs in water | were to each other as the numbers 21 to 3, 16 to 2, and 4 to 2. |
| „ Square discs in water | |
| „ Wooden balls in water | |
| Of Circular discs in air | were to each other as the numbers 25 to 18, 22 to 1, and 10 to 2. |
| „ Square fans in air .. | |
| „ Wooden balls in air.. | |

Mr. Bidder doubted whether the question of resistance, or friction, could be fairly tested by a cylinder revolving in a fluid, inasmuch as a rotary motion was imparted to a portion of the water, in the same direction as the revolution of the cylinder.

The subject was one of great interest, and to which he had devoted much attention. Some years since he assisted Mr. Walker in a series of experiments in the East India Dock, and he came to the conclusion, that it was not possible to arrive at one law suitable for all cases. There were in reality three cases to be considered:—

First. The resistance due to displacement.

Secondly. The resistance due to non-pressure.

Thirdly. The resistance due to friction.

As regarded the first case; the resistance due to displacement included that of the area of resistance of the water heaped up against the bows, which augmented as the velocity increased. In such case he found, that the increase of resistance was in a more rapid ratio than the square of the velocity.

In the second case; that of non-pressure, occasioned by the filling up of the channel in the wake, vacated in the passage of the vessel through the water. In this case he found the resistance increased in a less ratio than the square of the velocity. In Mr. Walker's experiments, boats were used with bluff prows and with acute prows; it was found that at a slight immersion, and when drawn at a low velocity with the bluff prow foremost, there was the least resistance; but that when deeply immersed, all other conditions remaining the same, there was the greatest amount of resistance.

As to the third position. The formula of Du Buat with regard to friction was found applicable; as there was no distinction whether the vessel was moving through the fluid, or whether the fluid was running over the bottom of a river. In this case the resistance due to friction was as the square of the velocity.

Bossut tried a variety of experiments upon the angles of resistance, by attacking to a rectangular parallelogram various shaped prows, at angles varying from 168° to 12°, with the view of ascertaining the law of resistance due to the angle of the plane meeting the water; but he overlooked the constant deduction necessary for the non-pressure due to the rectangular form of the stern, which formed the largest portion of the resistance, and consequently invalidated the deductions from the experiments.

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[1] See Bouguet, Traité des Navires; Euler, Scientiæ Navalis; Clairbois, Architecture Navale; Duhamel, ditto, ditto; Don Juan, Examen Maritime; Chapman (Sweden), Naval Architecture; Forfait, Traité sur la Mature des Vaisseaux; Attwood, Philosophical Transactions; Dupuis, Géométrie Déscriptive; Poisson, Théorie des Ondes; D'Alembert and Bossut, Recherches pour la Societe des Experiences en Architecture Navale; Lagerhjelm and Kallstenius, Experiments for the Swedish Society; Marestier, Memoire sur les Bateaux à Vapeus; Beaufoy, Nautical Experiments.

[2] Beaufoy's "Nautical Experiments." Vol. I. London, 1834.

[3] Thomson's "Annals of Philosophy." 1814.

[4] "Remarks on Canal Navigation." By W. Fairbairn. 8vo. London, 1831.

[5] Vide "Phil. Trans.," 1831, p. 423.

The view Mr. Bidder took of the mode in which the subject should be considered, was not with reference to the reflection of the particles due to the angle of incidence, but with reference to the absolute velocity imparted to the particles of water the vessel would have to displace. For instance, if the angle of the vessel was such, that the sine was one-half the radius, then the velocity of the particles in contact would be reduced one-half, and the resistance would be reduced to one-fourth; subject to the previous explanation of the heaping of the water against the bows.

With reference to a plane disc dragged through a fluid; it formed for itself a sort of natural prow of dead water, which was drawn forward with it; but the form of this prow varied with the velocity of the passing current, and hence the anomalies which had been observed in all experiments on the subject.

He could not agree with the infallibility of the Pitot tube; for he thought, that in proportion as the vertical tube was moved from the stem, an error must arise from the lifting of the stem and the dropping of the stern as the velocity increased.

Palmer's experiments gave anomalous results. The resistances came out as the tubes rather than the squares of the velocities. This Mr. Bidder thought must be attributed, in a great degree, to the friction arising from the small area of the channel, as compared to the surface of the body of the boat, and that of the sheet of pent-up water between the flat bottom of the boat and the bottom of the shallow canal.

In trying experiments upon large vessels, he conceived, that a tug boat could scarcely get up sufficient speed to obtain satisfactory results, and that it was necessary for the vessel to be floating in perfectly still water, in calm weather; or else the circumstances being changed the results must be modified accordingly.

As regarded the resistance offered by the paddle floats, when they were dragged through the water, as alluded to by Mr. Heppel, when it was remembered that the absolute velocity of the paddles impinging upon the water did not usually exceed 4 miles per hour, to propel a vessel at the rate of 12 to 15 miles per hour, it would follow, that as soon as the engines were stopped, unless the paddles were disengaged simultaneously, they would be dragged through the water at the same velocity at which the vessel was proceeding. In that case, the resistance offered by the paddles, would be so enormously disproportionate to that offered by the body of the vessel, as to render the results entirely nugatory.

Mr. Walker confirmed Mr. Bidder's statement of the results of the experiments tried in the East India dock, which were communicated to the Royal Society in 1827.[7] The machinery employed for those experiments was very simple. It consisted of a crab-winch with a barrel 3 feet in diameter, and handles of a sufficient length for the necessary number of men to work at it. The line, of ⅝ inch diameter, was attached at one end to the barrel, and at the other to a dynamometer in the bow of a boat, 18 ft. 6 in. long, by 6 feet broad, with a depth of immersion of 2 feet; the greatest immersed cross section was 9 feet. The experiments were tried in the Import Dock, where there was a space of 1,410 feet in length, 560 feet in width, and 24 feet in depth; so that there was no resistance from the sides or bottom of the dock. The velocities were calculated from the time of passing through 176 yards, or one-tenth of a mile; that length being marked off in the middle of the distance traversed by the boat. The speed was attained by a given number of men working at the winch, and was regulated by the vibration of a pendulum.

The results obtained were, that in almost every instance the resistance showed an increase, amounting to the square of the velocity for the distance traversed; but where the velocity was considerable the resistance followed a still higher ratio. In a narrow channel the increase would have been considerably greater. The excess beyond the square, must, he conceived, be attributed, in a great degree, to the raising, or heaping, of the water against the bows at high velocities, and to the simultaneous depression of the stern.

In these experiments the weight, or power, required, was of course, at least, in the ratio of the cube. For instance, if one man at the winch produced a velocity = 1, eight men were required to produce a velocity = 2; but as in the same time double the space was passed over, the exertion of power over the same space was the half of 8, or 4; but the velocity being twice the former velocity, it required twice the power, or eight men while they were at work; the distance was, however, traversed in half the time, so that the expense of power by doubling the velocity was only as 4 to 1.

The results shown by dragging the bluff prow or the sharp prow foremost, at various velocities, showed clearly, that very different figures should be taken for vessels intended for carrying cargo, from those intended for great speed.

Mr. Bidder said, that Mr. Barlow, in his deductions from Mr. Palmer's experiments,[8] stated, "that in the case of loaded canal boats the resistance varied in a higher ratio, viz.: as the cube of the velocity very nearly, if not exactly," and from the experiments he had computed the power of traction on a canal, thus:—

At 4 miles per hour 1 lb. would draw 200 lb.
At 2 miles „ 1 lb. „ 1600 lb.

The rule adopted by some of the principal marine engine makers (as Messrs. Boulton, Watt, and Co.),[9] for ascertaining the sailing qualities of the vessel, viz.: multiplying the sectional area by the cube of the power, and dividing the product by the velocity, had, he believed, been found a true test; and if when the power in the same vessel had been increased, the quotient had been found uniform, which he had also reason to believe was the case, another proof was afforded of the correctness of the theory, of the resistance being as the square of the velocity.

Mr. Spiller thought the results of Mr. Palmer's experiments were to have been anticipated, from their being tried in a narrow and shallow channel; the progress of the boat was necessarily retarded by the friction of the water against the sides and the bottom, a mass of water was carried along with the boat, and not having space to expand, reacted against the boat, unduly increasing the resistance, particularly at high velocities, Under ordinary circumstances the resistance would be as the square of the velocity, and a vessel going at a given velocity required eight times the power.

Mr. Scott Russell, thought the incongruities in the results of the experiments arose from want of due attention in noting all the circumstances attending them. The forms of the vessels were not particularly registered, nor were the various forms experimented upon, under similar circumstances. Now, as the law of resistance must vary with every difference of form, although a general rule might be given, it could not be relied upon in practice, and it became essential to analyse every experiment carefully before any deduction was made. One point to be particularly noticed, was the resistance of different forms of the bows of vessels, and of the quarters, as the law would vary as they were changed. Any experiment made in a channel of contracted dimensions, perhaps only three or four times that of the area of the midship section, could not be trusted; the law of resistance would vary with the form and dimensions of the channel, and great allowance must be made for lateral friction. In short, as a practical man, and speaking upon the authority of nearly ten thousand experiments, made upon large vessels in open spaces, under every variety of circumstances, he must still think the mode of experimenting by the steam-tug that which was best calculated to furnish accurate results.

Nor was he less wedded to the observations by Pitot's tube, using it as an instrument for measuring velocity. He would of course have the zero point adjustable; and its delicacy might be further tested by having another tube beside it; one of them indicating the immersion, and the other the velocity.

Mr. R. Stephenson said, the object appeared to be, to ascertain the law of resistance with respect to large vessels, as deductions from the experiments on small bodies did not seem to apply. He could scarcely agree in the propriety of relying upon the results obtained by dragging a vessel through the water by a steam-tug, which was only capable of obtaining low speeds. He thought that a steam vessel contained within itself the best mode of trying experiments, by means of the indicator attached to the engines. He was of opinion, that method would be found preferable to any other, if the vessel was tried at various rates of immersion, different speeds, and under circumstances that enabled deductions to be drawn.

Mr. Bidder replied, that in practising such a mode of experimenting, it would be first necessary to ascertain with accuracy the slip of the paddles, and the allowance to be made for the angles of impact and the depth of immersion, all which difficult problems were as yet little treated of and but imperfectly understood.

He was not satisfied with the accuracy of the Pitot tube, even as a measure of velocity, as the statical pressure must be affected by the varying velocity, and false results would be indicated.

Mr. Scott Russell said, it was true that if the tube and the funnel mouth

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[6] Vide Minutes of Proceedings, 1842, vol. ii. p. 102.

[7] Vide Phil. Trans., 1828, vol. cxviii, p. 15.

[8] Vide "Trans. Instit. C.E.," vol. i, p. 165.

[9] Extract from a letter from J. Brown, Esq., dated January 28th, 1833:—

In the years 1818 and 1819, Mr. Watt made a series of experiments with his vessel, the 'Caledonia,' to ascertain her velocity under different circumstances, and amongst the rest, the effect with one engine disengaged from the other. Each was nominally 14 h.p., and the operation of uncoupling one occupied about five minutes, so that the trials in both instances were precisely under the same circumstances as to tide and wind.

A measured mile in Long Reach was run with and against the tide six or eight times, and the average taken.

In 1818, with paddle-wheels of 10 feet 6 inches diameter, the results of these experiments were as follow:—

| | Miles. |
|---|---|
| With both engines at work, eight experiments gave average | 8·01 |
| With one engine ditto, eight experiments gave average | 6·17 |
| In 1819 these were repeated with paddle-wheels 13 feet diameter:— | |
| Both engines working during eight experiments, gave an average of | 8·33 |
| One engine „ eight ditto | 6·64 |
| Again, both ditto „ eighteen ditto | 8·29 |
| One ditto „ eighteen ditto | 6·24 |
| Similar trials were made with the 'Magnet' in 1827. Two engines of 60 h.p.—with | Miles. |
| Both engines at work during four experiments, the average speed was | 9·72 |
| One engine ditto „ four ditto | 7·42 |

You will remark, that the velocity with one engine in all these experiments, is something under what should arise, but is accounted for from the circumstance, that the number of strokes per minute, was reduced below the maximum, from the excess of load.

The results are however sufficiently near to establish the fact, that the power required is as the cube to the velocity, and according to this the 'Caledonia' experiments in 1818, with one engine, should have given 6·35 miles, instead of 6·17 miles; and in 1819, 6·72 miles, instead of 6·64 miles; and 6·58 miles, instead of 6·24 miles.

In none of these experiments was the indicator applied to the engines; the actual power exerted by each was, therefore, not ascertained, but the nominal power was taken.

In those of the 'Magnet' this instrument was used in the experiment quoted, and the actual power, when both engines were at work, was ascertained to be equal 227 h.p., giving 9·72 miles velocity; with one engine 103 h.p., 7·42 miles velocity; which is within the second place of decimals what it should be, say 7·47 miles.

were large and the orifice was near the surface of the water, the effect apprehended by Mr. Bidder would be produced; but with a small tube and a proportionate orifice, with a proper arrangement of the apparatus, having the orifice immersed from 10 feet to 15 feet beneath the surface, the statical pressure was so uniform at all velocities, that no sensible variation could be observed, and he must record his conviction, that if properly graduated, and conveniently arranged, no instrument he had hitherto seen possessed the same amount of advantages for trying experiments.

## ON REACTION WATER-WHEELS.

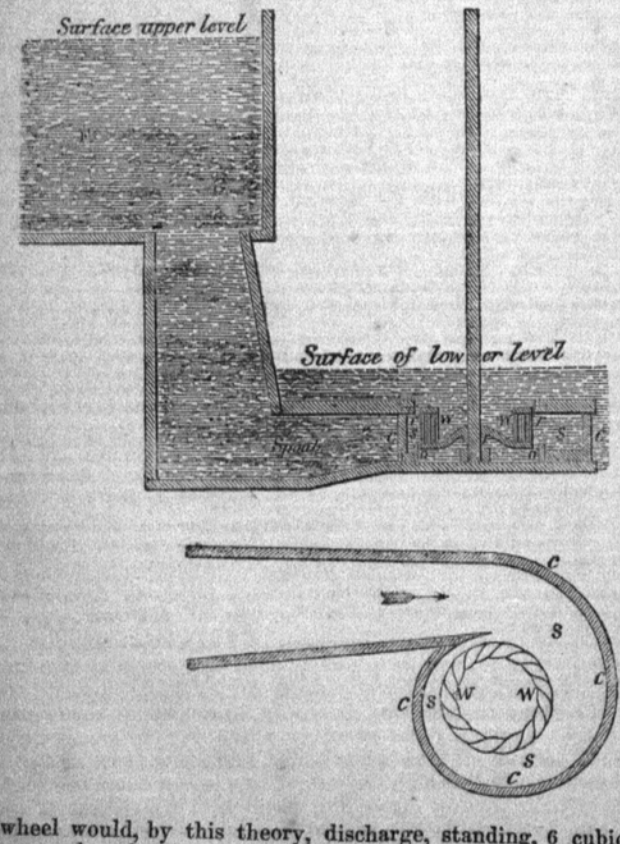
*Communicated to the Franklin Institute, United States, by* Z. Parker, *of Philadelphia.*

On the subject of Barker's wheel, which, with a few exceptions, appears to be the only reaction wheel noticed in the elementary books till recently, I have seen no notice of any variation in the discharge, caused by variations in the velocity of the wheel; from which I infer that the writers regarded them as uniform in their discharge under all velocities. In practice, however, it has been observed that, when the wheel runs without resistance to its free motion, the orifice moves with a velocity considerably greater than that due to a pressure of the head of water, and that the discharge is greater than the theoretic discharge. So far as I am informed, no experiments have been recorded, or rules given for determining the ratio of discharge under different velocities of such wheels.

The following rule, I think, will be found to hold good for all wheels of the reaction kind which discharge the water at their verge, and into which it enters without circular motion, or in which a circular motion of the water is caused by the wheel itself—the supply being full:

"To the head of water actually pressing at the orifice, add such a head as will, by its pressure, produce a velocity equal to the circular motion of the orifice; the velocity through the moving orifice will be the same that it would be if stationary, and under the pressure of the sum of the heads." For example:—

Suppose such a wheel to have an issue of 36 square inches, under a head of 9 feet, and that the orifice move at the rate of 16 feet per second; the discharge will be the same that it would be if the wheel were standing under a head of 13 feet. Consequently such a wheel would, by this theory, discharge, standing, 6 cubic feet per second, and running at that rate, 7·2 cubic feet. And if the orifices were suffered to move at the rate of 24 feet per second, the discharge would be the same as if standing under 18 feet head; in which case, the discharge should be 8·48 cubic feet per second.



It is obvious that, in applying this rule in practice, such deductions must be made (as in other cases) as may be due to the form of the orifice, the angles in the passages, and the friction on surfaces.

The following experiments were made with a centre discharge reaction wheel of the form and proportions represented in the accompanying sketch. The wheel was 34 inches in diameter at its outer verge; the inner diameter of the annular rim 26 inches. It had 16 issues (8 by 1·8 in.) = 230 square inches. It received the water at the verge, from an involute sluice embracing the whole circumference. The water was conducted to the involute through a large spout; the discharge of which into the involute 24 in. wide by 14 inches deep, = 336 square inches. The terminus of the involute was within an inch of the verge of the wheel. The circular motion of the water caused by the involute coincided with the motion of the wheel.

| | Power Expended. | | | | Effect Produced. | | | |
|---|---|---|---|---|---|---|---|---|
| No. of Experiments. | Fall of water in feet, = $h$. | Cubic feet of Water used per minute, = $d$ | Pounds of Water per minute, $d \times 62{\cdot}5 = w$. | Whole power of water, in lb. descending 1 foot per minute $h \times w = p$. | Weight on lever of break = $w'$ | Revolutions per minute = $v$. | Effective force of wheel, $w' \times v \times 60 = f$. | Ratio or practical co-efficient, = R. |
| 1 | 8·66 | 1125·5 | 70,312·5 | 608,996 | 30 | 143 | 255,600 | ·411 |
| 2 | 8·62 | 1119·0 | 69,937·5 | 602,861 | 39 | 138 | 312,920 | ·518 |
| 3 | 8·61 | 1119·0 | 69,937·5 | 602,861 | 45 | 130 | 351,000 | ·582 |
| 4 | 8·59 | 1104·0 | 69,000·0 | 592,711 | 66 | 87 | 344,520 | ·579 |

The condition of the works at the time the experiments were made was favourable to the wheel. It had run about two months after being repaired and adjusted, and the proprietor (Mr. A. Atwood, of Troy, N.Y.,) stated that it was performing as well as it ever had. There was a fault, however, in the construction. The "spout" (so called) conducting the water from the flume had an elbow of nearly a right angle, first descending from the bottom of the flume and then passing horizontally to the involute; the section at the commencement of the horizontal portion being about 16 by 36 = 576 square inches. The opening into the "spout" from the bottom of the flume was about 30 inches square, with sharp angles. All things considered, I am of the opinion that this method of employing the "pressure" of water, with a good structure, in good condition, is capable of giving about 62 per cent. of available power.

A remarkable feature of inward-discharging reaction wheels is found in the smallness of their discharge, and its tendency to uniformity under all velocities of the wheel, obviously arising in this application, from the outward pressure of the circular motion of the water in the involute sluice and wheel.

The theoretic discharge of 230 square inches, under a pressure of 8·61 feet, is 2,249 cubic feet per minute. The actual discharge is only ·498 of this. Had the discharge been outward, through the same aggregate aperture, and with the same circular motion of water, in the portion of the wheel occupied by the vanes, the discharge (judging from the results of my experiments made in 1844), would have been ·884 of theoretic discharge; and had it been outward, and *without* circular motion, it would have been about 1·289, at the speed of maximum power.

## ON THE VELOCITY OF ATMOSPHERIC JETS.

The following table (communicated by Z. Parker to the *Franklin Journal*) of the velocity of atmospheric jets, under the given pressures, may be useful.

The table is constructed under the assumption that all fluids acquire equal velocities under the pressure of equal heights, without regard to their specific gravities; allowing the superincumbent column to be homogeneous with that portion at the jet. The formula is $V = \sqrt{64\,h}$; and for a pressure of 15 lb. per square inch, $h = 27{,}600$ feet of homogeneous atmosphere. The height for other pressures in proportion.

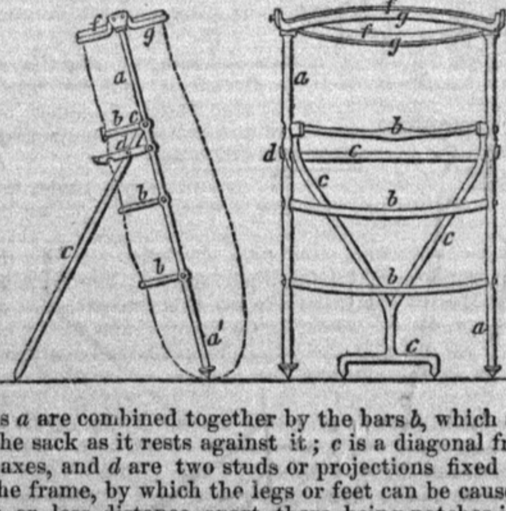
| Pressure per square inch. | Velocity, feet per second. | Pressure per square inch. | Velocity, feet per second. | Pressure per square inch. | Velocity, feet per second. |
|---|---|---|---|---|---|
| ¼ oz. | 42 | 2¼ lb. | 514 | 13 lb. | 1237 |
| ½ .. | 60 | 2½ .. | 533 | 14 .. | 1284 |
| 1 .. | 88 | 2¾ .. | 569 | 15 .. | 1329 |
| 2 .. | 121 | 3 .. | 594 | 20 .. | 1534 |
| 3 .. | 148 | 3¼ .. | 615 | 30 .. | 2004 |
| 4 .. | 171 | 3½ .. | 642 | 40 .. | 2170 |
| 5 .. | 190 | 3¾ .. | 665 | 50 .. | 2406 |
| 6 .. | 210 | 4 .. | 686 | 60 .. | 2658 |
| 7 .. | 227 | 4½ .. | 728 | 70 .. | 2871 |
| 8 .. | 242 | 5 .. | 760 | 80 .. | 3069 |
| 10 .. | 271 | 5½ .. | 804 | 90 .. | 3240 |
| 12 .. | 297 | 6 .. | 840 | 100 .. | 3431 |
| 14 .. | 321 | 7 .. | 908 | 110 .. | 3600 |
| 1 lb. | 343 | 8 .. | 970 | 120 .. | 3759 |
| 1¼ .. | 383 | 9 .. | 1029 | 130 .. | 3912 |
| 1½ .. | 420 | 10 .. | 1085 | 140 .. | 4060 |
| 1¾ .. | 453 | 11 .. | 1136 | 150 .. | 4202 |
| 2 .. | 485 | 12 .. | 1208 | 160 .. | 4340 |

## REGISTER OF NEW PATENTS.

### SACK HOLDER.

**Henry Gilbert**, of St. Leonard's-on-Sea, surgeon, for "*Improvements in apparatus for holding sacks to facilitate the filling of them with corn or other materials.*"—Granted May 27; Enrolled November 27, 1847.

Heretofore when filling sacks it has been usual for one person to hold up the sack whilst the other fills the same. In other cases the sack has been hung from hooks or instruments from a wall or post or some other permanent structure. The object of this invention is so to arrange apparatus that it may be carried about with facility, and stand in a field or other place, and uphold a sack in an open state so that the sack may be filled with facility; the invention simply requiring such an arrangement of parts that it may be independent of a fixed or permanent structure, and be capable of being moved from place to place, and yet uphold an empty sack in an open state and allow of a person readily filling the same. The annexed engraving shows a side and back view of the apparatus. *a* is the main frame, having two legs *a'*.



The sides *a* are combined together by the bars *b*, which are bent to receive the sack as it rests against it; *c* is a diagonal frame which turns on axes, and *d* are two studs or projections fixed to the side rails of the frame, by which the legs or feet can be caused to stand a greater or less distance apart, there being notches in the projector to receive the studs or projections. At the upper part of the apparatus is fixed an elliptical frame *f*, through which the mouth of the sack is to be drawn. The upper part of the sack is to be folded over the bars *f*, and the clamping-bars brought down, which will clamp the upper parts of the sack securely between the parts *f f*, and *g g*, by which means the sack will be held open at the mouth and supported or suspended from the frame *f*, and the apparatus may be placed in the position shown in the side view.

### STEAM-ENGINES.

**William Bacon** and **Thomas Dixon**, of Bury, Lancaster, engineers, for "*certain Improvements in steam-engines.*"—Granted August 19, 1847; Enrolled February 19, 1848. [Reported in the *Patent Journal.*]

The invention of improvements specified and enrolled under this title applies generally to that class of steam-engines usually termed Woolf's engine, or the compound-cylinder engine; that is, an engine having two cylinders, where the steam is admitted into one cylinder, at a high pressure, where having actuated the piston of that cylinder, it is admitted thence to the larger cylinder, where it again produces a motive power, and usually subject to condensation. In one case also, herein specified, it is applicable to single-cylinder engines. The patentee states that in the ordinary arrangement of compound-cylinder engines, the area or content of the passages from the expansive valve for the high-pressure cylinder to the inside of the low-pressure cylinder are such as to form a large proportion to the cubical content of the high-pressure cylinder; and that this content or space is filled, at the conclusion of each stroke of the engine, whether it be the upward or downward stroke of the low-pressure piston, with steam of a similar density as that produced by its admission into the low-pressure cylinder, which in many cases is five or six pounds, or even more, below the pressure of the surrounding atmosphere. When the return-stroke of the piston takes place, the steam admitted to effect the preceding stroke of the high-pressure piston is passed into the passage or space before-mentioned, thence to the low-pressure cylinder, where it joins with the before-mentioned rarified steam, and therefore the steam in, or escaping from, the high-pressure cylinder, is considerably reduced in pressure, without producing a corresponding amount of force on the piston. The principal object of these improvements is to obviate in a great measure the before-mentioned deterioration of the steam in its passage from one cylinder to the other, and also to simplify the construction and at the same time to obtain an increased amount of duty from the steam in compound-cylinder engines. To attain the advantageous results just enumerated, the patentees construct their improved engine so that by a peculiar arrangement of the passages, valves, and openings, the exhausting-valves for the high-pressure cylinder, or admission-valves for the low-pressure cylinder, are placed as nearly as possible to the ports or entrances to the low-pressure cylinder. On account of this arrangement of the passages between the steam-valves for either of the ports of the low-pressure cylinder, and the opposite end of the high-pressure cylinder, these passages are constantly filled with steam of the same density as that in the high-pressure cylinder; therefore, the content of the passage from the valve to the entrance of the low-pressure cylinder is the additional extent of the space the steam admitted to the high-pressure cylinder will have to occupy, and the steam always be in reserve for the commencement of the stroke of the low-pressure piston; consequently the pressure of the steam will be reduced but to a very trifling degree; and, therefore, they argue that a more perfect expansion of the steam in the low-pressure cylinder is obtained, which is attended with a corresponding additional result in the motive-power. These improvements consist:—First, in so arranging the valves, passages, and openings, that one valve-box, one double hollow valve (or two sliding-valves of the common construction) are adapted to serve for both the high and the low-pressure cylinders. The same passage in the valve which admits steam to the top of the low-pressure cylinder from the bottom of the high-pressure cylinder, in a downward stroke of the pistons, also forms the passage from the top of the low-pressure cylinder to the condenser, in the upward stroke of the pistons; and the same passages in the valve which admit the steam to the bottom of the low-pressnre cylinder from the top of the high-pressure cylinder, in the upward stroke of the pistons, also forms the passage from the bottom of the low-pressure cylinder to the condenser, in the downward stroke of the pistons. The same part of the valve which admits the steam to the low-pressure cylinder forms the exhausting-valve for the opposite end of the high-pressure cylinder. Secondly, these improvements consist in using separate plate or other valves for the admission of the steam to the high-pressure cylinder, and using these valves as expansion-valves with which to cut off the steam from the high-pressure cylinder, and so arranging them that the amount of expansion may be varied to any required extent in the high-pressure cylinder without interfering with the ingress or egress of steam to or from the low-pressure cylinder. Thirdly, these improvements consist in arranging conical-valves, Cornish, or other description

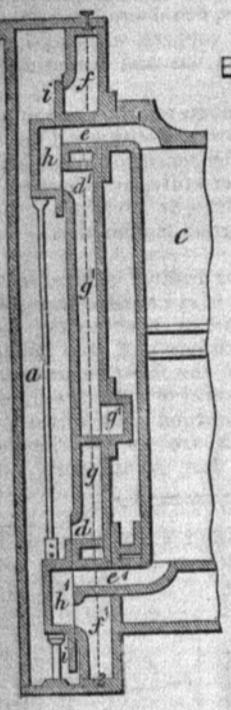


Fig. 1.

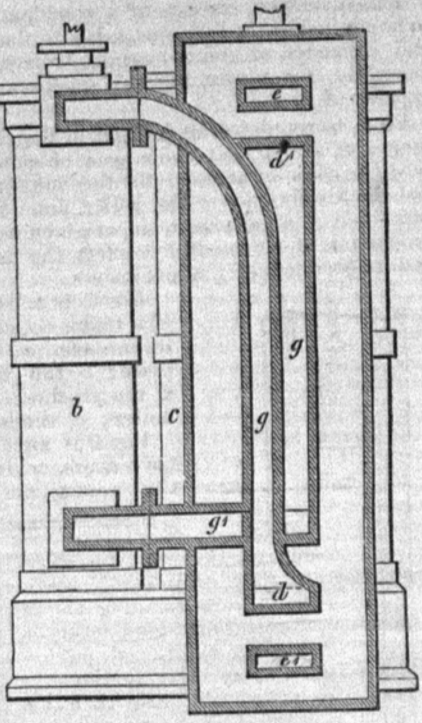


Fig. 2.

of disc-valves for compound-cylinder engines, so as to effect the same result as by the slide-valves above-mentioned, and in arranging each valve to be raised by a separate tappet (or by other mechanical means), so that any one valve can be closed without interfering with any of the others; by reason of which arrangement any amount of expansion or compression of steam in either the high or low-pressure cylinder can be effected. Fig. 1 represents a vertical section of a low-pressure cylinder, together with the steam-passages, so arranged that by one valve-box, six openings, and two common, single, hollow sliding-valves, they are adapted to serve both the high and low-pressure steam-cylinders; and fig. 2 is a transverse vertical section of the passages through the line 1, 2, showing also the position of the cylinders. *a* indicates the admission and exit openings for the top of the high-pressure cylinder; and $a^1$ the opening for similar purposes to the bottom of the high-pressure cylinder; and *b*, and $b^1$, the ports for the admission and escape of steam to or from the top and bottom of the low-pressure cylinder; *c*, and $c^1$, the passages to the condenser; *d*, and $d^1$, steam-passages to the high-pressure cylinder; *e*, and $e^1$, the hollow sliding-valves; and *f*, and $f^1$, the lap or covering for the condenser-ports *c*, and $c^1$. The action of this arrangement is as follows:—Steam being admitted from the boiler to the valve-box *a*, enters at *d* (when the valves are in the position shown), and passes thence by the passage *g*, to the top of the high-pressure cylinder *b*, where, having performed the downward stroke of the engine, the position of the valves *h*, $h^1$, will be reversed, and the steam will return by the passage *g*; and the opening *d* (as well as the port $e^1$), being now covered by the valve $h^1$, the steam will be conducted thereby below the piston of the low-pressure cylinder *c*, and, on a subsequent stroke taking place, it will escape through the valve $h^1$, to the port $f^1$, and thence by a suitable passage to the condenser. For the upward stroke of the engine, the port $d^1$ will be uncovered by the valve *h*, and steam will enter, passing by the passage $g^1$, to the bottom of the high-pressure cylinder, and by the change in the valves it will escape from thence by the passage $g^1$, through the valve *h*, into the top of the low-pressure cylinder *c*, where, having performed its office, it is exhausted by the condenser through the passage *f*, which, in its turn, will be covered by the valve *h*. The ports *f*, and $f^1$, are always covered either by the valves *h*, and $h^1$, or by their projecting-pieces *i*, and $i^1$. Fig. 3 represents a vertical section of a valve-case, together with the requisite passages, by which arrangement one valve-casing, five openings, and one double hollow slide are made to serve for two high-pressure cylinders and one low-pressure cylinder, these being arranged, in the drawings, one on either side of the low-pressure cylinder, to which the slide-case and slides are attached; the different valves, openings, and passages are lettered severally, as in the last figures, and to which the description thereof will be equally applicable, as the steam is conducted precisely in the same manner as in that case. Fig. 4 is a vertical section of a low-pressure steam-cylinder, with its valves and openings so arranged that by one valve-box, eight openings, two plate expansion-valves, and two common, single, hollow slide-valves are adapted to serve one high-pressure steam-cylinder, and one low-pressure steam-cylinder. Fig. 5, a section through the line 3, 4, showing the arrangement of the passages, with the relative position of the two cylinders. A, represents the valve-case; B, the high-pressure cylinder; C, the low-pressure cylinder; *a* is the opening in the valve-face, which is connected with the top of the high-pressure cylinder by the passage *b*, which passage also serves to convey the steam from the top of the high-pressure cylinder B, to the bottom of the low-pressure cylinder C. $a^1$ is the opening in the valve-face for the admission of steam to the bottom of the cylinder B, the passage $b^1$ communicating thereto; this passage serves as a communication between the bottom of the high-pressure cylinder B, and the top of the low-pressure cylinder C. These openings *a*, and $a^1$, are covered alternately by two expansive plate-valves *c*, and $c^1$; which valves are furnished with suitable apparatus for varying the amount of expansion, and are placed on the same rod as the valves *d*, and $d^1$, which are for the purpose of controlling the direction of the steam in its entrance and exit to and from the low-pressure cylinder C. *e*, and $e^1$, are the steam-passages to the cylinder C, and *f*, and $f^1$, the openings in the valve-face to the condenser; *g*, and $g^1$, are the openings in the valve-face to the steam-passages *b*, and $b^1$; and *h*, and $h^1$, the laps of the slides *d*, and $d^1$, for the purpose of covering the openings *f*, *g*, $g^1$, and $f^1$. Steam being admitted to the valve-jacket from the boiler, at a high-pressure, it enters at *a*, to the passage *b*, which is filled as far as $g^1$; that opening being covered by the lap of the valve $d^1$, it is conducted thereby to the top of the high-pressure cylinder B, where, having performed the down-stroke of the piston, the position of the valves will become changed, the steam in the top of the cylinder B, will escape by the passage

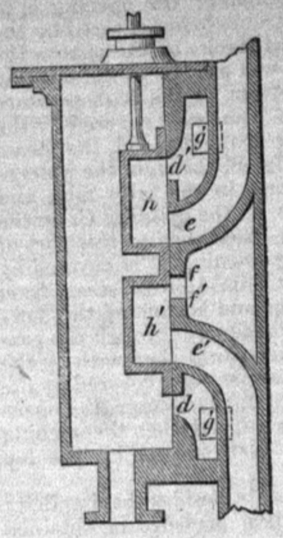


Fig. 3.

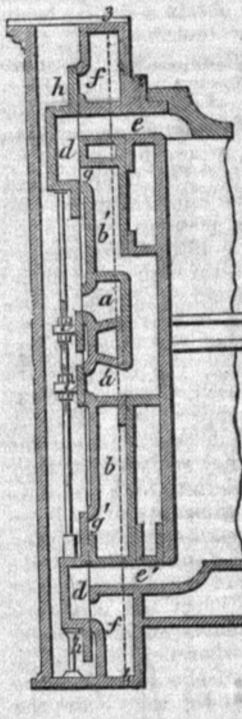


Fig. 4.

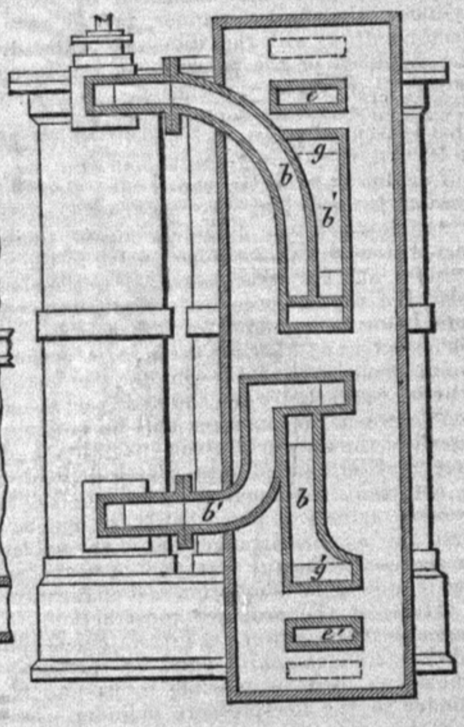


Fig. 5.

*b*, through the opening $g^1$ in the valve-face, which will now be covered by the valve $d^1$, and by it directed through the passage $e^1$ into the bottom of the low-pressure cylinder; the opening *a*, to the passage *b*, during this part of the stroke, being covered by the expansion-valve *c*. During the upward stroke of the pistons the high-pressure steam in the valve-case will pass in at the opening $a^1$, thence by the passage $b^1$ to the bottom of the high-pressure cylinder, the opening *g* to this passage being now covered by the lap of the valve *d*; but the valves being again changed, the steam will rush from the bottom of the cylinder B, through the passage $b^1$, where it passes through the opening *g* in the valve-face, and is directed by the valve *d* into the top of the cylinder C, by the passage; when the down-stroke takes place, during this part of its course through the passage $b^1$, the opening $a^1$ is covered by the expansive-valve $c^1$, preventing any admission of steam from the valve-case. The steam from the top and bottom of the low-pressure cylinder is exhausted by the condenser through the passages *f*, and $f^1$, which communicate alternately therewith by the change in the valves, *d*, and $d^1$; when the opening is covered by the valve *d* and the steam directed thereby to the condenser, the opening $f^1$ is covered by the lap $h^1$ of the valve *d*, and when the opening $f^1$ is covered by the valve $d^1$, *f* is in its turn covered by the lap *h* of the valve *d*.

The object aimed at in these improvements, besides the simplicity of construction, are, that a more effective pressure is obtained from the admission of the steam immediate on the opening of the steam-valves to the low-pressure cylinder, and, consequently, a more effective result is obtained. Drawings are represented in the specification, showing the application of Cornish or disc-valves adapted to effect the admission of steam to the low-pressure cylinder in a similar manner, and so as to obtain a similar beneficial result, as with the slide-valves already described; but, from the simplicity of the principle of the invention, it will be unnecessary to give any description. In combination with these foregoing improvements, they also specify an improved apparatus for what is techically termed "blowing through" when an engine is to be started, the improvements being for the purpose of preventing the engine starting in the wrong direction. The improvement consists in arranging two passages from the blow-through valve to the low-pressure cylinder, one of these passages being connected from the blow-through valve to the top of the low-pressure cylinder, and the other passage from the blow-through valve to the bottom of the low-pressure cylinder—the openings into these passages being so regulated by a three-way cock or valve, that when the operation of blowing through is performed, the steam enters simultaneously on each side of the piston in the low-pressure cylinder; and that when the said valve is closed, any communication between the passages will be entirely prevented. Having described the nature of their invention, and in what manner the same may be carried into practical effect, they remark that they do not claim the application of one valve-box to high and low-pressure cylinders, but what they claim as their invention is:—First, the peculiar arrangement of the valves and openings as they are represented in the cuts and hereinbefore described in detail; that is to say, the adaptation and application of a reduced number of valves, of the ordinary construction, to effect the necessary communications between the steam-chest, cylinders, and condenser; and the arrangement of ports or openings, whereby the steam is reduced as little as possible in passing from the high-pressure cylinder to the low-pressure cylinder. Secondly, they claim the application of two high-pressure steam-cylinders to one low-pressure steam-cylinder, and in so arranging the ports or passages that the same number of valve-boxes and openings which serve for one high-pressure and one low-pressure steam-cylinder, will also be sufficient for two or more high-pressure cylinders and one low-pressure cylinder. They desire it to be understood that they do not confine themselves, in the application of the improvements, exclusively to compound-cylinder engines with condensation, but also claim the application of their improvements to compound-cylinder engines without condensation, passing the steam from the second or low-pressure cylinder into the atmosphere instead of into the condenser. Thirdly, they claim the application of their improvements in the methods of blowing through for the purpose of starting engines, as applicable to every description of double-acting condensing engines, whether with compound cylinders or a single-cylinder engine. They also claim any combination of the improvements herein specified, whereby similar objects may be accomplished.

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## CONSUMING SMOKE.

**William Edward Kyan**, of Westbourne-park-villas, Paddington, clerk, for "*Improvements in consuming the smoke and economising the fuel of steam-engines, breweries, and manufactories generally.*"—Granted July 25, 1847; Enrolled January 25, 1848.

This invention consists of a combination of mechanical means, to be applied to the furnaces, ash-pits, flues, fire-doors, door-frames, and chimneys of steam-engines, boilers, coppers, stills, and pans generally, for consuming the smoke and gas and lessening the expense of fuel.

First, to regulate the draught of the chimneys, whatever may be their altitude, so that their area of cubical capacity shall not exceed the conjoint areas of the furnace,—the space above the bridge and the fire-flue under the boiler, &c. Secondly, by adjusting the admission of atmospheric air, at given points, to afford the precise proportion of air needful to effect the perfect combustion of fuel, and its products of gas and smoke.

Fig. 1 is a longitudinal vertical section of a steam-boiler of cylindrical form, with its furnace. *a*, the furnace-doors; *b*, the plate; *c*, the fire-bars; *d*, the bridge; *e*, the air-flue; *f*, the fire-flue under the boiler; *g*, the lateral or side fire-flues.

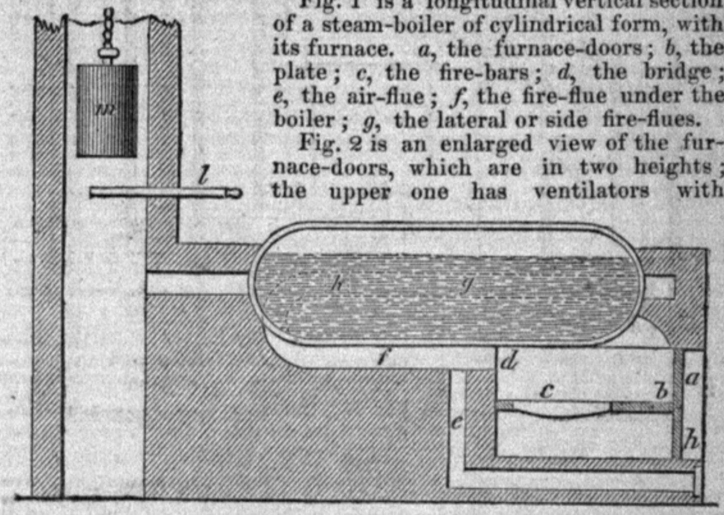


Fig. 1.

Fig. 2 is an enlarged view of the furnace-doors, which are in two heights; the upper one has ventilators with regulating slides to admit the air over the fuel (without lessening the temperature of the furnace which partly opening the door occasions), and is opened to supply fuel; and when that is done, it is closed, and the lower (plain) door is then opened to arrange the position of the fuel on the bars. *e* is the air-flue with ventilator to regulate the air admitted. *h*, *h*, are the ash-pit doors with their ventilators, by which the needful quantity of air is allowed to enter. There is a second air-flue marked *k*, which enters the side flue into which the blaze first passes from the boiler, and this has likewise a ventilator marked *l*.

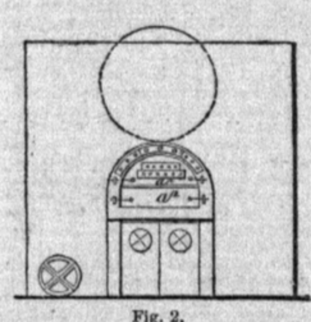


Fig. 2.

In addition to the horizontal damper in the machinery to contract and regulate the draught, there is also a vertical damper fixed on one side of the chimney with a counterpoise weight, which damper is raised as occasion may require, to supply a volume of air to the chimney, and thereby lessen or stop the draught through the furnace at the time when fuel is supplied and arranged on the bars.

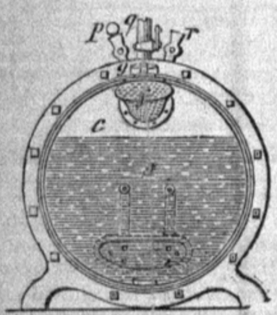
The air is to be admitted gradually as required. Thus—by the admission of a moderate quantity through the ventilators of the ash-pit doors, the fuel is ignited—by the supply of air through the ventilating holes regulated by slides in the door-frame, above the doors, or in the upper door (as the case may be), combustion is afforded to the gas and smoke while arising in the body of the furnace, by the air supplied from the ventilator in the air-tube or flue which communicates to the back of the bridge, any gas and smoke which escapes from the furnace to the flue under the boiler, is ignited. And again, by the ventilator in the second air-flue, marked *k*, entering the side flue at the end of the boiler, near the chimney, still further ignition is attained, and the full completion of the combustion is thus secured by the conjoint action of the whole of these arrangements, which could not be effected by the admission of a large volume of air with undue force at any of these given points above enumerated.

These arrangements are also applicable to boilers of marine steam-engines. Thus, where the boilers are set in brickwork, with flues or fire-bed passing under the boiler, and side flues surrounding the boiler, like those of stationary land-engines, the same method of applying the arrangements as before described will answer the purpose, and where the furnace and ash-pit are within the boiler, the ventilators are to be applied to the ash-pit doors, to the furnace door-frame and upper door, and to a metallic pipe to convey air to the back of the bridge, and should there be a slide-flue, one also to that; the regulating damper to the chimney and a vertical damper enclosed for safety in a case open at the bottom to admit air.

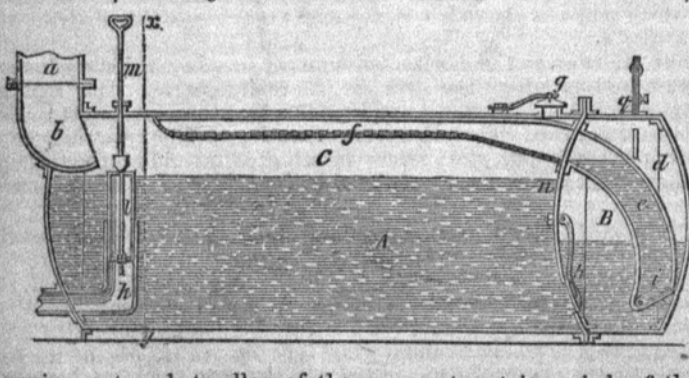
As some of the arrangements herein described are old, or have been in use, such as the horizontal damper, the divided furnace-door, with apertures therein, and the admission of air at the back of the bridge, the patentee does not claim any one of these separately, but claims their application combined with the following improvements (that is to say) the vertical damper marked *m*, the openings in the door-frame, and slides to cover them occasionally, the side air-flue, and ventilator *k*, and that marked *e*, the ventilators in the ash-pit doors, and the tube for conveying the air to the back of the bridge, marked *e*, in the manner set forth, to produce, by their regulated and united action, the effect of more complete combustion, by igniting the gas and smoke, and thereby saving fuel to a considerable extent.

## CONDENSER FOR STEAM-ENGINES.

**Christian Schiele**, of Manchester, mechanician, for "*Improvements in machinery or apparatus for condensing steam.*"—Granted May 27; Enrolled November 27, 1847.



The new condenser consists of a cylinder A, one end of which is divided off, forming a separate chamber B; the two chambers are connected by a valve *h*, in the partition *n*, and a tube *e*, leads from near the bottom of the small chamber into the large one, proceeding along the upper part of the cylinder, and having its lower surface pierced with holes. The cylinder contains water, and on steam being admitted from the engine, through the pipe *e*, into the large chamber A, it forces the water through the valve *h* in the partition into the small chamber; but as soon as the steam begins to condense, and the pressure on the surface of the water is released, the compressed air in the small chamber forces the water up the connecting-tube *e*, and which, flowing along, passes through the orifices *f* in a shower, and completes the condensation. *k* is an elbow-pipe, in connection with the force-pump of the boiler, to carry off the condensed fluid; it is provided with a vertical tubular slide *l*, to be raised to any suitable elevation by a rod *m*, to regulate the level of the condensed fluid, and steam space *c*. *g* is a valve on the upper part of the chamber, opening outwards to allow of the escape, at certain periods of the operation, of any steam or air contained in the chamber. *p* is a glass gauge-ball, in communication with the chamber B, by means of a small pipe, which depends from the top of that chamber to about one-fifth of its depth. This ball *p* is intended to show the diminution of the air in the chamber B, by the rise of the fluid into it. *r* is a small pipe with a stop-cock, for supplying air to the chamber when required. A third pipe *q* is connected with the chamber B, and is intended to furnish a fresh supply of water from an elevated cistern, in order to compensate for the fluid lost by leakage.



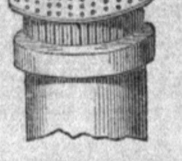
## GAS BURNERS.

**John Hunt**, of Birmingham, brass-founder, for "*Improvements in the combustion of gas, oil, camphine, and other substances which are or may be burned for the production of light.*"—Granted July 3, 1847; Enrolled January 3, 1848.

This invention relates to the application of caps or discs, made of perforated metal or wire gauze, to the tops of the chimneys or glasses of gas, oil, or other lamps, as shown at fig. 1.

The second part of the invention relates to the manufactuer of argand burners and the chimney-holders attached thereto. Fig. 2 is a vertical section of a burner and chimney-holder. In the ordinary method of making them, the several pieces are joined by soldering at the parts marked *a*, *a*; but the patentee proposes to cast in one piece either the outer cylinder *b*, and the bottom *c*, and rim *d*, of the glass-holder, or the inner cylinder *e*, and the bottom and rim of the glass-holder; or, instead of casting, it can be made the same by stamping from sheet-metal. The completion of the burner by the addition of the inner or outer cylinder, as the case may be, is effected by the ordinary process of soldering.

Fig. 1.



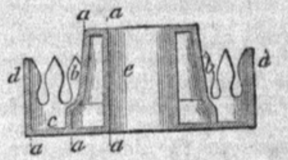


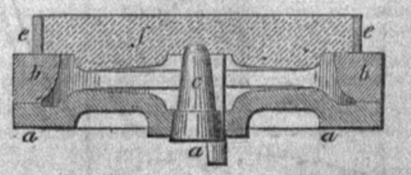
Fig. 2.

## RAILWAY BREAK.

**Frederick Chaplin**, of Bishops Stortford, Hertfordshire, tanner, for "*Improvements in wheels of railway carriages.*"—Granted June 29; Enrolled December 29, 1847.

The improvements consist in applying to the tyres of railway wheels belts of hide, skin, or leather, in such a manner that they will come in contact with the rails on which the wheels travel, whereby the driving-wheels of a locomotive engine will be enabled to take a firmer hold of the rail, and the wheels of the railway carriages will travel more slowly and with less noise.

**Railway Wheels.**—Patented June 28, 1847, by **W. E. Newton**, of Chancery-lane, consisting of a peculiar method of casting the iron wheels for locomotive engines and railway carriages, the object being to cool uniformly all parts of the casting at the same time, and thereby preventing fractures from irregular shrinking. From the time when wheels with a chilled hub and flange were first brought into use, the difficulty of casting them has been known, for the chill sets and cools the metal of the rim before the spokes or parts connecting it with the hub, and these, in cooling, shrink, and either break, or become so weak as to break on the least strain. To obviate this, the hub was for a long time made in sections, to enable it to open and yield to the contraction of the spokes, but this was attended with a diminution of strength, and the necessity of putting on wrought-iron hoops or bands. The patentee avoids these objections, which is effected by casting the whole wheel in a chill, and cooling all the parts at the same time, and without undue strain on any part. For casting a wheel of this kind a circular metal mould is to be constructed in several pieces, as shown in the annexed engraving, which, when put together, will leave an internal recess, or chamber, to receive the molten metal, corresponding to the figure of the intended wheel when complete. A quantity of molten metal being poured into the mould, the cast wheel will be produced, the inner face, flange, and outer periphery of the felloe being chilled and hardened by the cold metal surfaces, against which the molten iron has come in contact, and by which means all parts of the casting, as it cools, will shrink uniformly, and have no tendency to strain and crack,



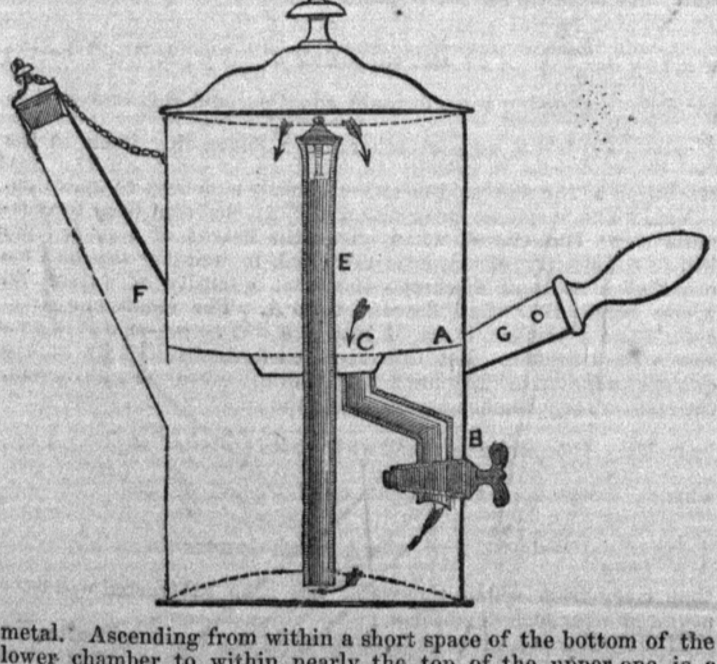
or separate one portion from another. *a* is the circular metal plate, and *b* a metal ring, accurately fitted together; *c*, a conical metal plug forming a core, with a feather *d* affixed, to form the recess for the key to fasten the wheel to the axle.

Silvering Speculums.—Patented August 3, 1847, by **T. Fletcher**, of Birmingham. It consists in coating glass, after it is silvered with metal, by the electrotype process, whereby the quicksilver is protected from injury, and a stronger power of reflecting light given to the speculum. The silvered glass plate is lightly and carefully coated on the back, or silvered side, with a varnish composed of two ounces of shellac, half a pint of highly-rectified spirits of wine, and half an ounce of the best lamp-black; this varnish protects the quicksilver from damp, and from the acid used in the subsequent process. Before the varnish is quite hard, shake over it from a muslin bag, finely-pulverised plumbago, black oxide of manganese, or any other metallic powder, or cover it with thin metal, so that the whole surface will be covered with a perfect but thin coat of metal; after which it is submitted to the electrotyping process, and by this means a thin coating of copper, or other metal, will be precipitated over the entire back of the plate.

Direct Application of Steam-Power to Mills.—Patented July 29, 1847, by **J. Hastie**, of Greenock. It consists in the application of direct action of steam-power to turn mills, by making the axis of the crank of the engine serve also for the axis of the mill—whether the same be vertical or horizontal. The shaft is provided with a fly-wheel, which receives an endless belt for driving flour-dressing machines, and on the shaft there is an eccentric for communicating motion to the slide valves. When two pairs of mill-stones are required to be worked by the same engine, it may be effected by causing the piston-rod to pass through both ends of the cylinder, and connecting it at each end with the shafts of the upper mill-stones; and, in case it should be at any time desirable to work only one of the upper stones, the other may be disconnected.

## WALLER'S PATENT COFFEE-POT.

This invention consists of a vessel divided into two equal parts by a dished partition A, with the centre depressed and pierced by a hole; around the edge is attached a bent tube connected with a cock B, forming a passage through the strainer C, from the upper to the lower half of the vessel; the strainer is finely perforated metal. Ascending from within a short space of the bottom of the lower chamber to within nearly the top of the upper one, is a tube E, passing through the centre of the partition and perforated plate, and which tube is surmounted by a valve D. F is an ordinary spout communicating only with the lower division, and fitted with a ground stopper.



The mode of using the apparatus is this: the stopper being removed from the spout, the water is poured into the upper half of the vessel, the tap is then turned downwards to allow the water to run into the lower half; when it has done running, the ground coffee is put into the top division, the tap again turned horizontally, the stopper re-inserted, and the vessel placed on the fire. When the rattling of the valve, and escape of steam from under the lid have continued a few seconds, the coffee-pot is to be taken quite away from the fire and allowed to stand about two or three minutes; the tap is then turned downwards, when the infusion will rapidly filter into the lower division, and be ready for use in a beautifully bright and boiling condition.

The principle of this apparatus will be readily perceived. When it is placed on the fire, the water in the lower division is forced by the pressure of steam up the central tube, lifting the valve, and made to fall in a uniform stream, *at a gradually increasing temperature*, upon the coffee; as soon as all the water above the inferior orifice of the central tube has been forced up, then only steam arises; when the vessel is removed from the fire the valve falls into its seat, and prevents the re-entrance of air into the lower chamber, after its total expulsion thence by the steam; during the period of infusion, the steam in the lower chamber is allowed to condense, and thus a partial vacuum is produced, and preserved for any period, and rendered available for effecting rapid filtration whenever desired, by the employment of the tap.

From experience we can state that this little apparatus is one of the most useful domestic articles that can be had. It produces the most brilliant and fragrant coffee in three or four minutes. We should observe that during the process the vessel is quite closed; consequently, not the slightest quantity of the aroma of the coffee is dissipated.

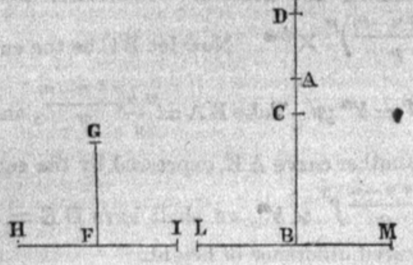
## ON THE FLOW OF WATER.

*Of the Union and Division of Running Waters, with the Laws of their Increase and Diminution.* By Bernardino Zendrini, della Città de Ravenna.—(Translated by E. Cresy, Esq., in his Evidence before the Metropolitan Sanitary Commissioners).

I. A river which unites with another does not cause this latter to rise in proportion to the quantity of water which it brings, as would be the case supposing water to be considered as a solid, but only increases the height by as much as the greater or less velocity of the influent or recipient may permit. On the contrary, if a river in the middle of a canal be diminished by a certain quantity of water, it ought to be lowered proportionally to the velocity of the canal of derivation and the river from which the water is abstracted, and such an alteration ought to be perceived not only at the lower part at the point where the water is added or subtracted, but also in the upper. In which law, however, there is much obscurity; what appears certain is, that both in the case of the union and of the separation that the surface continually adapts itself to the alteration in a regular progression, and although the impression arising from such an anomaly does not disturb the whole level of the river if it runs over a long course, it reduces the problem to find the point where the disturbed mixes and unites with the undisturbed surface after following the oscillation of the water, which point in geometric rigour ought to traverse the whole length to the source of the river, since it would describe a regular curve; but the course of the water encounters so many impediments and obstructions, that these laws do not really obtain. And in every river there is, in fact, a point beyond which the regurgitation does not take place. That, however, as much as possible, we shall treat of in another chapter, when speaking of the falls of rivers, of their highest rise and lowest levels.

For the present it will be sufficient to seek the elevation or depression which will be produced in a river by the addition or subtraction of a quantity of water.

II. Suppose A B to be the height of a recipient previous to the influx of another stream, let L M be its width in a given section, F G the height of the influent before the union, H I its width. Supposing this latter introduced into the recipient, it ought to experience a certain rise. What will that rise be? Since the additional water ought to conform to the width of the section of the recipient, conceive the height F G of the influent altered to that of the recipient A E, then the water of the one will have passed into the other, and since this fresh water presses upon the other, that of the recipient will be obliged to lower its surface, and from the point A will be brought down to C; likewise the point E will pass to D and E D = A C, and consequently B D will be the entire height of the recipient after the addition of the influent water.



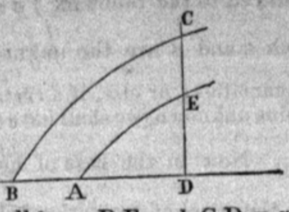
Calling $AB = d$. $AE = x = CD$. $BD = z$. $FG = b$. $HI = a$. $LM = c$. The velocity of the recipient before receiving the influent $u$. Its velocity after having received it, but before it could exercise any pressure and reduce it to equilibrium; that is the same which it would have if the water of the influent ran in the width of the recipient $= t$, the velocity which the recipient has after the union and after the waters have equilibrated in their course $= q$, and the velocity which the influent had in its own level before the union $= r$. Then since the two masses of water of the influent and recipient in a given and equal time can pass separately in the level of the recipient, they ought to be able to pass together through the aforesaid recipient. Hence the equation $du + tx = qz$ and $z = \frac{du + tx}{q}$ first general formula; now since equal masses of water pass in equal times both through the influent separately and through the aforesaid influent when reduced to the width of the recipient, we shall have $ctx = abr$, whence $x = \frac{abr}{ct}$ and $z = \frac{cdu + abr}{cq}$ the second general formula expressing the whole height BD; wherefore AD, which is the whole increment produced by the influent above the first state of the recipient will be $\frac{cdu + abr - cdq.}{cq}$

III. *Corollary* 1.—If the velocity be a mean proportional to the height, we shall have $AD = \frac{d\sqrt{d} + x\sqrt{x} - d\sqrt{z}}{\sqrt{z}} = z - d$, which reduces itself to $z = \sqrt[3]{(d^3 + 2dx\sqrt{dx} + x^3)}$ and $AD = \sqrt[3]{(d^3 + 2dx\sqrt{dx} - x^3)} - d$, in which $x = \frac{b\sqrt[3]{aa}}{\sqrt[3]{cc}}$, as is obtained by substituting in the formula $ctx = abr$, the values of $t$ and $r$, which are $\sqrt{x}$, $\sqrt{b}$, which value of $x$ if substituted for that of $t$, will give the value of AD.

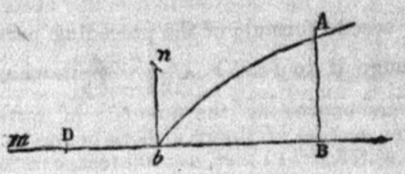
IV. *Corollary* 2.—On the supposition of Castelli and of Barattieri, that the velocity will be as the height, we shall have $x = \sqrt{\left(dd + \frac{abb}{c}\right)}$ and $AD = \sqrt{\left(dd + \frac{abb}{c}\right)} - d$.

V. *Corollary* 3.—And consequently if $u = d^m - r = b^n\ q = z^\phi$ where $m$, $n$, $\phi$ are numbers which may be integers or fractions expressing any power of the height by the velocity, we shall have the general formula $z = (d^{m+1} + a \times c^{-1}\, b^{n+1})^{\frac{1}{\phi+1}}$, in which $x$ being already eliminated, it only remains to substitute the values of $d$, $a$, $c$, $b$, taking the aforesaid exponents as fixed, supposing $z$ $d$ unknown, the aforesaid formula will give the general equation of the whole curve of the increment of the river by the addition of the other stream, the abscissa of which will be $z$, the ordinate $d$, or more generally making $u = d^{\frac{m}{p}}$, $r = b^{\frac{n}{p}}$, $q = z^{\frac{\phi}{p}}$, we shall have $c\, z^{\frac{\phi+p}{p}} = c\, d^{\frac{p+m}{p}} + a\, b^{\frac{p+n}{p}}$, and that $z^{\phi+p} = \left(\frac{c\, d^{\frac{p+m}{p}} + a\, b^{\frac{p+n}{p}}}{c^p}\right)^p$, and we shall be able to determine the relation of $z$ to $d$ in the following manner:—

Let $d^{\frac{p+m}{p}} = b^{\frac{m}{p}} y$; now $d^{p+m} = b^m y^p$; we shall have $z^{\phi+p} = \left(y + \frac{a\, b^{\frac{n+p-m}{p}}}{c}\right)^p \times b^m$ Construct the curve AE expressed by the equation $d^{p+m} = b^m y^p$. Take $BA = a\, b^{\frac{p+n-m}{p}}$, and from the point B describe another curve, which has for its equation $z^{\varphi+p} = \left(y + \frac{a\, b^{\frac{n+p-m}{p}}}{c}\right)^p \times b^m$, we shall have $DE = d$, $CD = z$, and the intercepted portion CE will be the increment required.



VI. *Scholium* 1.—In the simplest case of the velocity in proportion to the height, using the first formula of the preceding corollary, change this into $dd = zz - \frac{abb}{c}$, the equation of the equilateral hyperbola $bA$, of which as well the parameter $bn$ as the diameter $bm = \frac{2b\sqrt{a}}{\sqrt{c}}$, wherefore DB will be the height after the union of the water, and BA the height which the recipient will have on first receiving it. And by the properties of the equilateral hyperbola, the square of BA being equal to the rectangular $Bm \times bB$, that is, to the difference of the squares DB, D$b$, we shall have analytically $dd = zz - \frac{abb}{c}$, which is the equation proposed; whence appears the method of describing such a hyperbola, so as to contain every possible case of increment arising from an addition of water. And calculating with the second formula the two parabolas of the preceding corollary, we shall have $dd = by$, $BA = \frac{ba}{c}$, and $zz = by + \frac{bba}{c}$; and if for $by$ we substitute its equivalent $dd$, we shall have $zz = dd + \frac{bba}{c}$, the equation which is found and constructed above.



VII. *Scholium* 2.—If the velocity is as the root of the height, the equation resulting from the first formula of § V will ascend to the sixth dimension of the unknown quantity, and the progression will be $c^4 z^6 - 2a^2 b^3 cc\, z^3 + a^4 b^6 - 2c^4 d^3 z^3 - 2a^2 c^2 b^3 d^3 + c^4 d^6 = o$, which does not transcend the limits of a cubic equation; but with the second formula $\frac{m}{p} = \frac{n}{p} = \frac{\varphi}{p} = \frac{1}{2}$ we shall have $z^3 = \left(y + \frac{ba}{c}\right)^2 \times b$; and supposing $d^3 = by^2$, AE will be the parabola expressing the aforesaid equation, and BC that of $z^3 = \left(y + \frac{ba}{c}\right)^2 \times b$, without otherwise embarrassing itself in the resolution of the aforesaid equation, already sufficient complicated.

VIII. The converse proposition to § II. deduced from the formula there enunciated, which gives the height of a river from which a quantity of water is deducted, to find the section of a canal, such as shall discharge the same quantity of water, and whose height BD shall descend to BA. The equation $cqz = cdu + abr$ is then changed into $abr = cqz - cdu$, which solves the problem. Let it be required to diminish it by such a quantity of water as may have to the first, before the subtraction, the ratio of $l$ to $p$, whence we shall have the analogy $cqz : cdu :: l : p$, by making $r = bn$, and $u = dm$, and we have $b = \left(\frac{c}{a} \times \frac{l-p}{p} \times d^{m+1}\right)^{\frac{1}{n+1}}$ whence we deduce the height of the canal of deduction $d = \left(\frac{a}{c} \times \frac{p}{l-p} \times b^{n+1}\right)^{\frac{1}{m+1}}$ formula, which denotes the height which that river from which the water has been subtracted will have acquired after such deduction.

If the water of a river be diminished by a given height after the canal or derivation be opened, and the height of the effluent $b$ is noted, required its breadth $a$. Let the first height before the deduction be to the second, after the latter has taken place, as $e$ to $f$; hence $z : d :: e : f$ whence $z = \frac{de}{f}$. Therefore by substituting this value in the general formula, since we have already $r = b^n$, $q = z^\varphi$, and $u = d^m$, the equation will be reduced to the following; $a = c\,\frac{e^{\varphi+1}d^{\varphi+1} - f^{\varphi+1}d^{m+1}}{f^{\varphi+1}b^{n+1}}$, in which $a$ and $d$ are the unknown quantities, and $c, f, b, z$, the given quantities; or else, if a certain breadth be given, and the height remains unknown, we shall have $b = \left(c\,\frac{e^{\varphi+1}d^{\varphi+1} - f^{\varphi+1}d^{m+1}}{a f^{\varphi+1}}\right)^{\frac{1}{n+1}}$. Now in the case of horizontal, or nearly horizontal streams, the canal of derivation being open, whose bottom regulates also the height of the water of the river; that is to say, the portion which acts to produce the greater or lesser quantity which it deducts, the other remaining inactive in regard to such a canal of derivation, the formula will be $d = \left(\frac{e}{f}\times\frac{cz^{\varphi}}{a+c}\right)^{\frac{1}{n}} = b$.

IX.—*Corollary* 1. In the second formula of the preceding paragraph let $m = n = 1$ we change it to $d = b \times \sqrt{\frac{ap}{cl - cp}}$ in which if $l = 4000$, $p = 3500$, numbers expressing the quantity of water which passes through a given section of the river both before and after the subtraction of the water, $b = 10$ feet, $a = 200$ feet, $c = 300$ feet, performing the proper operation, the logarithm of $d = 1{\cdot}3345034$ answering to $21\frac{122841}{202034}$. The value of the first height before the diminution will be $z = \frac{d\sqrt{l}}{\sqrt{p}}$, where $d$ being known, all the other quantities will be known also, and will be $23\frac{8858}{92417}$ feet.

X.—*Corollary* 2. Making $m = n = \frac{1}{2}$, which is the case of Torricelli, Mariotti, and others, transmuting the aforesaid second formula into $d = b\,\sqrt[3]{\frac{aapp}{cc(l-p)^2}}$, and $z = \frac{d\,\sqrt[3]{ll}}{\sqrt[3]{pp}}$, substituting the proper quantities and placing the values of the quantities $l, p, b, a, c$, as above, the logarithm of $z = 1{\cdot}4846658$, the number to which is $30\frac{75446}{142405}$, from which it appears that if the river be lowered by the water, diminished by the effluent so that the first height shall be to the second after the diminution as $23\frac{8858}{92417}$ to $21\frac{122841}{202034}$, the quantity which passes through a given section below the point of diminution, before the water is subtracted, will be to the quantity which passes through the same section after the water is subtracted as 40 to 35 in the first case, and the height in the second case as $30\frac{75446}{142405}$ to $27\frac{146407}{157942}$.

XI. *Corollary* 3. Taking the third formula of the preceding paragraph, in which we have supposed $e, f, d, b, c$ given, making $n, \phi, m = 1$, by the hypothesis of Castelli, let us seek the width of the canal of derivation. We shall have $a = \frac{cdd}{ff}\times\frac{(ee - ff)}{bb}$. Suppose $e : f :: 9 : 8$, $d = 20$, $b = 18$, $c = 300$, the logarithm of $a = 1{\cdot}9929051$, corresponding approximatively to the number 98, of so many feet will be the width of the canal of derivation, that the first height may be to the second, after the water is diminished, as 9 to 8; but on the supposition that $m, n, \phi = \frac{1}{2}$, will be the formula changed to $a = \frac{cd\sqrt{d}}{f\sqrt{f}}\times\frac{(e\sqrt{e} - f\sqrt{f})}{b\sqrt{b}}$, and the logarithm nearest to $a$ will be $1{\cdot}8900925$, whose nearest number, 78, will be the width required.

XII. *Corollary* 4. Using the general formula, $z = \frac{cdu + abr}{cq}$, to obtain the residual height of a river, after a certain quantity of water has been subtracted, we shall have $d = \frac{cqz - abr}{cu}$. Now by substituting for $q, r, u$, their respective values $z^{\phi}, b^{\delta}, d^{m}$, we shall have $d = \left(\frac{cz^{\varphi+1} - ab^{\delta+1}}{c}\right)^{\frac{1}{m+1}}$; if then $\varphi, \delta, m$ will be equal each to $\frac{1}{2}$, we shall have the equation,

$$d^6 - \frac{2a^2b^3d^3}{c^2} + z^6 - 2d^3z^3 - \frac{2a^2b^3z^3}{c^2} + \frac{a^4b^6}{c^4} = 0.$$

Or if, for greater simplicity, we reduce it to the following expression, $d = \sqrt[3]{\left(z^3 - \frac{2zcx^2\sqrt{bz}}{abb}\times x^3\right)}$; and since $x = \frac{b^3\sqrt{aa}}{\sqrt[3]{cc}}$, we shall have $d = \left(\frac{\sqrt[3]{ccz^3 - 2cabz\sqrt{bz} + aab^3}}{\sqrt[3]{cc}}\right)$.

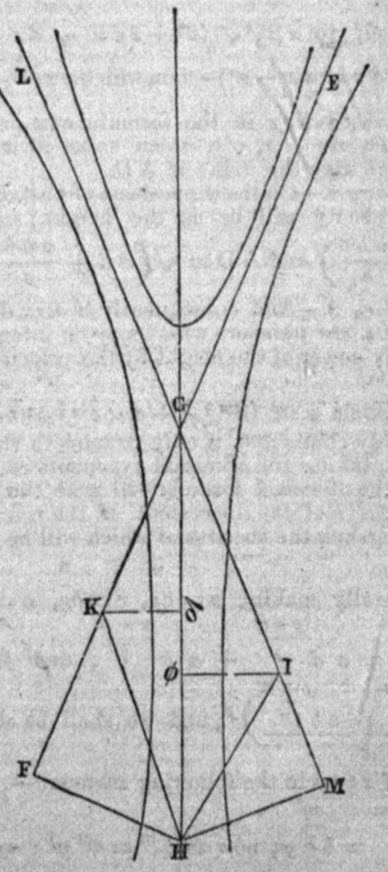
XIII. *Corollary* 5.—Using the preceding formula, in which we have constructed two parabolas, according to what has there been laid down,

$cd^{\frac{p+m}{p}} = cz^{\frac{\phi+p}{p}} - ab^{\frac{p+n}{p}}$, and thence $d^{\frac{p+m}{p}} = z^{\frac{\phi+p}{p}} - \frac{ab}{c}^{\frac{p+n}{p}}$, now $d^{p+m} = \left(z^{\frac{\phi+p}{p}} - \frac{ab}{c}^{\frac{p+n}{p}}\right)^{p}$, and making $z^{\frac{\phi+p}{p}} = b^{\frac{m}{p}}y$ we have, making the necessary substitution $d^{p+m} = \left(y + \frac{ab}{c}^{\frac{p+n-m}{p}}\right)^{p}\times b^{m}$. Now let B C be the curve whose equation is $z^{\phi+p} = b^m y^p$. Take B A $= \frac{ab}{c}^{\frac{p+n-m}{p}}$, and from the point A describe another curve A E, expressed by the equation $d^{p+m} = \left(y - \frac{ab}{c}^{\frac{p+n-m}{p}}\right)^{p}\times b^{m}$, we shall have D E $= d$, C B $= z$, and C E the required difference of height.

XIV. *Scholium* 1.—We shall give some examples of the fall of the surface of rivers, produced by derivative canals, as they have been called, and these examples will be taken from the Adige, which, as is known, affords many such, and on which I had cause, at various times, to make several observations for its general regulation. It was found

1st. That the Bova della Badia, in flood time, measures 10.7.4 Venetian feet, or 1528 lines, above the sill; $a$ its breadth is $12\frac{1}{2}$ feet, or 1800 lines. The reduced height of the Adige, opposite it, at flood time, was 11.3.1, or 1621 lines, being 402 feet wide, or 57888 lines; now by a preceding rule, § VI., in which we supposed the velocity as the height, having $x = \frac{b\sqrt{a}}{\sqrt{c}} = 269$, and consequently $d = \sqrt{(zz - xc)} = 1598$, which being subtracted from the height of the Adige before the diminution, there remains 23 lines, that is 1 inch 11 lines for the required diminution.

2nd. At the mouth or sluice of the Sabbadina we found that $z = 19.1.11$, or 2759 lines; $b = 9.2.11$, or 1231 lines; $a = 27\frac{1}{2}$ feet, or 3960 lines; $c = 2280$ feet, or 30240 lines, whence $x = 554$ and $d = \sqrt{(zz - xx)} = 2703$, which, deducted from 2759, the first height, gives 56 lines or $4\frac{2}{3}$ inches.



3rd. At the sluice of the New River, when it was of wood, it was found that $z = 10.8.4 = 1480$ lines, $b = 4.10.8 = 704$

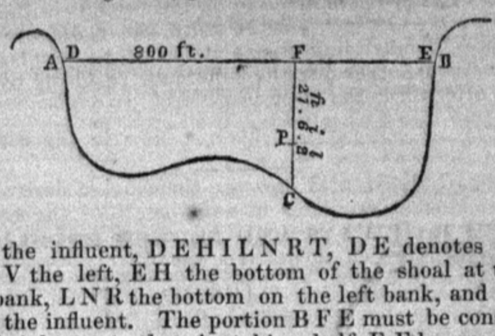
lines, $a = 60$ feet $= 8640$ lines, $c = 318$ feet $= 45792$ lines, and $x = 306$, and $d = 1441$, giving $2\frac{5}{8}$ inches for the diminution of the Adige.

4th. At the Fossa Bellina which is the lowest of the derivatives with respect to the sea, it was found that $z = 10.11.8 = 1580$ lines, $b = 4.4.2 = 626$ lines, $a = 60$ feet $= 8640$ lines, $c = 258 = 37512$ lines. Whence $x = 301$ and $d = \sqrt{(zz - xx)} = 1531$, which subtracted from 1580, leaves 29 lines for the diminution of the Adige, that is 2 inches and 5 lines.

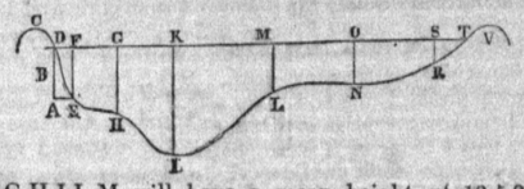
5th. But at Castagnaro, which is the first and farthest from the sea of all, it was found that $z = 14.2.10 = 2050$ lines, $b = 1491$ lines, $a = 35064$ lines, $c = 95040$ lines; dimensions taken above the two falls on each side of the Cunetta, which remains in the middle, the result of which calculated separately will be $x = 850$ lines and $d = 1816$ lines, a sum which diminished by 2050 lines, leaves 234 lines, or 1.7.6, for the diminution of the Adige at the flood time, by reason of the diversion, which the two falls are able to produce on each side of the Cunetta. Calculating then the diminution of this, we have $z = 2050$ lines, $b = 2127$ lines, $a = 3816$ lines, $c = 95040$ lines, as above, whence $d =$ nearly 2000 lines, which, subtracted from 2050, leaves 50 lines, or 4 inches 2 lines, wherefore we have for the whole diminution of the Castagnaro 1.11.8, or within 4 lines of 2 feet.

XV. *Scholium* 2. The celebrated Abbate Guido Grandi, mathematician of the Grand Duke of Tuscany, in his treatise on the motion of water, professes "that if two horizontal rivers, L G, F G, moved with a velocity, I G, G K, be united in one trunk, whose velocity and direction will be G H; and, on the other hand, supposing the said trunk H G, has the velocity H G, it ought, with the retrograde motion to divide itself into two branches, G L, G F, they will not regain the velocity, I G, K G, equal to the first, unless the angle, L G F, be a right angle," the which being different from what we have before established, we are obliged to examine, according to our power, the foundation on which the aforesaid proposition rests. Grandi resolves the total velocity, G H, which arises from the two, G K, G I, by means of the complement of the parellelogram with the two lines expressing the force, H E, G E, of which H E is the perpendicular let fall on G K produced; but if conversely, says he, the trunk, H G, he resolved into branches, whose velocity shall not be the same as on entering the trunk, it may be greater or less, and will only be equal in the case when the angle, L G F, is a right one. The direction of the velocity, G H, resulting from the conjunction of the two laterals, G I, G K, is exactly what all staticians have laid down. To have a clear proof: on the line G H raise the perpendiculars, $K\delta$, $I\phi$, and the velocity, G K will be obtained, resulting actually from the two $G\delta$, $\delta K$, and the velocity G I, in the two others, $G\phi$, $\phi I$, of which $K\delta$, $\phi I$, nowise contribute to the progressive motion, but only $G\delta$, $G\phi$, then $G\delta + G\phi$ are equal to G H, as is more easy to demonstrate; then each quantity denotes really the velocity with which the water in the trunk moves after receiving the influents, and it is to be noted that the prevalence of one perpendicular $K\delta$, above the other $I\phi$ will only oblige the branch to bend a little from its course. Wherefore the illustrious author then considers the converse of the proposition, that is, when the trunk passes into the branches, to resolve the velocity, H G, into two, H E, E G, and says, that in G F the water will run with the velocity G E, greater by the acute angle than G K, the which will be true, whatever bend and through whatever arm, G E, all the water of the trunk may flow, whilst H G does not express all the velocity, the same quantity not going through G E, which did when G F was considered as an influent, it results that H G ought to resolve itself in another shape than that which is the case, that is, considering $G\phi$ by the velocity G I, and $G\delta$ by the velocity G K, whence the original velocity, G K, G I, in the two canals respectively, will be precisely restored, now reputed as different branches, G F, G L; whence the conversion of the influents into diffluents will not change the velocity; in either case it will be retained, provided it be not changed by any external circumstance.

XVI. *Scholium* 3.—I think it would not be superfluous to give an example of the increase of height which a river really acquires from the reception of another. We will suppose the velocity a mean proportional of the height, using the preceding formula $z = \sqrt[3]{(d^3 + 2dx\sqrt{dx} + x^3)}$. The average depth of the section of the recipient $= 3962$ lines $= d$, its breadth 115200 lines $= c$. The true section of the recipient is figured, in which A and B denote the profile of the banks, C the bottom, D E the surface of the water, P F the average depth; the next figure is the section of the influent in which the shoal E H appears much more elevated than the bottom I and B M S the surface. The better to adapt it to practice and calculation, I shall divide the section into several parts, reducing them one by one to the section of the recipient, which then added together, gives the amount of increase. In the



section of the influent, D E H I L N R T, D E denotes the right bank, R T V the left, E H the bottom of the shoal at the toe of the right bank, L N R the bottom on the left bank, and H I L the bottom of the influent. The portion B F E must be considered of the mean height 3.0.4, that is taking half E F by reason of the triangle B F E or B A E, the base B F is 11 feet, or 1584 lines, wherefore performing the necessary operation, we shall have $z = 3963$ lines, from which subtracting 3962 lines, the average height of the section, there remains one line for the increase of that portion B F E. Likewise through the portion F G H E, 17 feet wide, and 6.0.9 feet high $= 873$ lines, we shall have $z = 3968$ lines, from which subtracting 3962 lines, there remains 6 lines for the increase of the recipient in height by reason of the aforesaid addition.



G H I L M will have a mean height of $13.5.3 = 1935$ lines, and a width of 126 feet $= 18144$ lines, whence $z = 4102$ lines, and this third increment will be 11 inches 8 lines. M L N O formed by the left lower shoal will have a mean height of 1333 lines and 100 feet 14400 lines, whence $z$ will be 4026 lines, and the height required for the increase caused by its addition $5\frac{1}{3}$ inches. The shoal O N S R is 26 feet $= 3744$ lines wide, and the mean depth 3 feet 6 inches 3 lines $= 507$ lines, and $z = 3966$, giving 4 lines for the increase. Finally, the portion comprising the escapement of the bank may be considered 8 feet wide, and 1.9.1. Its reduced height not giving any sensible increase, collecting together all the aforesaid measures, we shall have the total increase of 1 foot 5 inches 11 lines.

XVII. *Scholium* 4.—According to what is registered in the visitation of the Po and Reno made in 1693, by Cardinal d'Adda and Barberini, to calculate the increase produced in the Po by the addition of the Reno, it will be necessary only to use the preceding formula, as likewise to find the same effect at the general visitation of 1720. Taking the data of 1693 aforesaid, supposing the average height of the Po without the Reno at Lagoscuro 31 feet $= 372$ inches, the height of the Reno at the pass of Annegati, that is $b = 9$ feet $= 108$ inches; the width of the Reno there $189 = a = 2261$ inches; the width of the Po at Lagoscuro 760 feet $= c = 9120$ inches, where $x = 3$ feet 6 inches, $d^3 = 51478848$; $2dx\sqrt{dx} = 3906000$ and $x^3 = 74088$ numbers, which added together make 55458936, whose logarithm is 7·7439015, which divided by 3, to obtain the cube root, gives log. 2·5813005, the number to which is $381\frac{3755}{10384}$; and since the fraction answers to 4 lines, if 372 is subtrcated from 381.4, there remains 9 inches 4 lines for the increase required according to the aforesaid supposition.

XVIII. *Scholium* 5.—In a report presented by Guglielmini at the time of the visitation, and which was registered in the Acts of it, and printed in the Florence collection, in which he calculates the rise at 8 inches 9 p. only, but the difference between us arises from his having taken the nearest numbers neglecting fractions. Eustace Manfredi, in answer to Giovanni Ceva, says in reply to the other proposition, "To say truly we shall find that the $9\frac{2}{3}$ inches found by Ceva, is one inch more than what results from the former calculation of Guglielmini, and that by a small error of a fraction," &c. [See Manfredi's notes to Guglielmini's book on the nature of rivers.]

XIX. *Scholium* 6.—In all the above examples we have supposed for the calculation of the velocity that it is either a direct or mean proportional to the height of the water, and that so as not to differ from what has been laid down frequently by many renowned authors; and also to give a proof of the manner of employing the formula we have discovered, when greater precision is required, the velocity must be found by an instrument (the hydraulic pendulum), and the formula used which we have given in a preceding chapter. It is possible that in some cases we may not be able to employ the rules above referred to for the velocity without making great errors; thus to seek out the truth as unequivocably as possible, in cases of much importance it is well to calculate by many different methods, observing the difference resulting from each to determine afterwards the most probable.

## FRENCH RAILWAYS AND FRENCH REVOLUTIONS.

At length the time has come when the French are awakened to the truth about their railway undertakings. There were very few who withstood the plan of government interference; it was thought quite right that the government should take charge of the railways, and private enterprise was crushed. We say crushed, because it had not free play, and because the concession system was a clog on those lines which were left in the hands of shareholders.

France is behind-hand with her railways: private enterprise when most wanted is dead, and the finances have been upset by the wasteful manner of making the government lines. M. Garnier Pagès, the new Minister of Finance, says this plainly, and names among the causes of financial embarrassment those great jobs, the government railways, made for placemen and not for the country. Thus a burden is put upon France, which she will very much feel, for taxation is at all times burdensome to the people, but always most in their times of greatest need. It was wrong that railways should be made by loans and taxes; but it was still more wrong, when the private enterprise of France was in its childhood, to take away from it the food, as it were, of growth. France has always been backward in such public works, and when there was a fair chance of getting the French to take shares in railways, they ought to have been put forward instead of being kept back. It has not been so, and France is burdened with the government railways, and the springs of private undertakings are broken up and can do nothing, when France wants them most.

If, however, the late government struck a great blow at joint-stock undertakings, the future government holds out no hope, for with the growth of socialist ideas, shareholders are frightened as to what may be their share in anything they may undertake. The working-man comes in now, and asks for his share in the newly-opened lines, and though it may be small at first, it may be very much afterwards, or it may be all. Railway undertakings are not those where this plan can be best tried, for the clerks and workmen have no very great means of making the traffic greater; for when a railway is made, the bulk of the traffic flows upon it, and though it may be nursed, yet, as we have said, the underlings can do but little for it. The shareholder does the most in making the line, and the working does not much want the care of others.

What may be the end to English shareholders in French railways we cannot undertake to say, but whatever may befall—if indeed all they hold now should be lost, there will be no loss on the whole, because the sale of shares to the French in 1845 and 1846, will more than make good whatever may be lost hereafter. On the first stake in French railways, the English made enough to make good their old stock, so that what they have left is only their gain. It may be, that so far as some are bound up in French shares, they may be losers; but most of the holders, as we have said, have made themselves safe. If, too, we take the income which has been had on the old stock and put by, there must be more than enough to meet any loss. We wish the shareholders were as well off in Flanders, but there the railways are only half made, no income has been had from them, very few shares have been sold, and there is little hope of a sale to the Flemings or the French. Therefore, so far as French railways go, there is no room for the outcry that English gold has been wasted abroad.

If there be no loss to the English in the end on French shares, the French themselves will lose, for there will be a withdrawal of that help which the English have given, and which has made and worked the few French railways now open. At a time when the French government must give up railway making, when French shareholders are borne down by heavy losses and cannot make the railways themselves, the French cannot look abroad, for the trust of the foreign holders is broken. However right it might have been to give the workmen a share in the income of the Great Northern Railway, and however needful it may have been, yet this step is the deed of the chairman alone, without one word from the shareholders whose income is handed over. M. de Rothschild, in taking this step, has taken it in haste; and it looks more like giving in to fear, than making a fair and careful bargain between the shareholders and the workmen. No one can help seeing that fear of the Communists wrought upon M. de Rothschild, for it was not enough to hold out the hope—they would not trust to that, he had to give at once all that they wanted. Every one will feel that when they ask again, and ask more, it must be given: the Communists are to ask, and the shareholders to yield. If the stake the shareholders have lately had be too much for them, so that they now have may be held to be too much; it is not left to the shareholders to say what is right—they have not even to make a bargain: the Communists have the might, and they have the right, and if they say five in the hundred is too much, the shareholders must give way. It is very true that lately the income of the holders in stocks and savings banks has been raised, but this only lays a heavier weight on France, and the day must soon come when these burdens will have to be lightened. Then it will be said, holders in savings banks take so much, stockholders take so much—railway shareholders must do the like. On these grounds, the holders here will be frightened, and will take no share in any new railways, whatever the wants of France may be.

If the late government of France had upheld joint-stock undertakings, there would have been a better knowledge of them, and the new government would have been more careful of meddling. They would have looked to them as a help and a stay when so many in France are out of work, and they would have found in them the best way of making the wealthy give food and work to the poor. A tax, however mild on the whole, can never fit itself to the means of every one; the golden mean will be broken—on one the tax will fall lightly, another will sink under it. A joint-stock share undertaking is a free-will loan, or a tax made by a man himself, knowing his means, and taxing himself to the utmost in the hope of gain hereafter. There is no fear of a man putting down too little, there is no fear of smuggling or shifting from under the yoke. A loan raised for railway works partakes of this in so far, that each gives as his means allow; but the hope of gain is not so strong to draw him on, while he is not the master of his own money, it is not laid out under his own care, it wants the eye of the master. It is on these grounds, as much as anything, that we uphold joint-stock undertakings in England; they bring to bear not only the money of the people, but their skill and powers of mind; and we shall grieve whenever in this country joint-stock undertakings shall be given over to the government, as Mr. Morrison and his followers have been so earnest that they should be. What the French did led them on, but we hope they are cooled by what has lately happened there; though we are not so strong in our belief that the government will leave off meddling while berths can be found for their many greedy hangers-on.

The turning out of France of the English workmen need not give us any sorrow, though it will do France no good. It is neither more nor less than self-slaughter by the French. Why did English workmen go there? Not as wanderers seeking a livelihood, not like the Swiss and others who crowd to Paris, and earn bread which Frenchmen might earn; but they have been asked to go there—they have been sought. English skill and English knowledge were wanted for French railways, French power-looms, and French engine works. There were no Frenchmen to do the work, and Englishmen were brought over to teach them. So far from the English doing as the Swiss—working under the French, taking away their livelihood, or shortening their earnings—the English have been always paid higher than the French, and have followed new callings in which no Frenchmen came in their way, while they have given help to the others by teaching them trades, which they did not know before. The power-looms and other weaving and spinning works of the north of France have been set up by the English, and carried on by English foremen; and thus the French have been brought into the market against us. The English foreman is to be found all over Europe, not because he is liked, but as they cannot do without him. This not in France only, but in Flanders, Holland, Germany, Italy, and Spain.

The withdrawal of English masters and English workmen from France is a blow struck at France, and not at us. Instead of Frenchmen fighting us with English weapons, they must take to their own, and be beaten as they were before. We do not believe that this swarm of Englishmen abroad did us the least good. They mostly laid out in France what they made there—they seldom brought anything back; and if we had not to keep the few thousands who lived there, still we must have lost by the Englishmen put out of work at home, who if they had to deal with the French only would have beaten them, for after all the English are far better in all the higher work. We shall have so many men brought home, and we shall have to keep them: it will be most likely by our taking trade from the French, perhaps by sending goods into France itself.

The French have a great fear of our trade, they believe that we sway the world by our trade, and they wish to wrest it from us—they begin the struggle by throwing aside their best weapons. To be great in trade, France should draw money and skill from the whole world; it should have chosen and picked men, whether from France or abroad. It should be the star to which men of mind and skill should look, as shining with the best hope of reward. The blow dealt at the English strikes elsewhere. It is not only the Englishman who is forbidden to take his stock, his knowledge, and his skill to France, but it is every man who is willing and ready to do so. The Italian, the Spaniard, the German is forbidden, and shut out as much as the Englishman. France is shut against the world as much as China was,—there is no field for any but Frenchmen.

We wish we could speak more hopefully, that we could cast a brighter look on France, but we feel we cannot with truth speak otherwise than we have. We believe we have spoken fairly, while we are sure that England, however it may wish that it had been otherwise, is the least harmed by the breach which has thus been made in the ties of fellowship which so lately knit the two together.

## HEALTH OF TOWNS BILL.

The promised bill for securing the health of towns is again before the legislature; and we hope with some prospects of success. To the general principles of the measure we are most favourable, because we have long laboured to obtain an amendment of the very serious evils which so much affect the public health. At the same time, there are many clauses which require great and grave consideration before they become law; and in making some remarks upon them, we do so without any hostility to the bill generally.

In clause 8, fifty householders have the power of putting the act in motion. In large towns, such a number gives the power to an insignificant minority; and in small towns, fifty may be found too many. There ought either to be a proportional number, according to the population of the town.

Although the eighth clause speaks of existing local boards, we do not find any provision for their abolition; and we therefore expect that great confusion will arise between the new local boards of health and the old local boards, for paving, cleansing, highways, sewers, and for other purposes. Great confusion must likewise arise from the election of new officers, who will be brought in conflict with the present clerks and surveyors.

The qualification of elected members of local boards seems too high for small towns. The number of inhabitants rated at thirty pounds a year is so small as to restrict the choice of the electors.

We think the provision for contour lines in clause 27, is useful; but if the lines are taken at every ten feet elevation, it will be quite enough.

By clause 29, the board of health will have the power of carrying a sewer or drain "*through or under any lands whatsoever.*" Surely this will never be allowed to pass; this power will enable any sewer to be carried across a garden, pleasure-ground, or park, without any notice or compensation.

Clause 35 requires that notice of building a house shall be given to the local board of health fourteen days, and that works shall not be begun without leave of the board. Seven days seems to us quite time enough, and the works should proceed unless the board can show some objection to them.

It appears very unlikely that clause 42 will be found practicable. It provides for engine and factory chimnies consuming their own smoke.

Clause 49, although aimed at great evils, is very objectionable; and however effective it may be in checking tramp-houses, it will not touch the evils of overcrowded Irish lodging-houses. It makes all houses, other than public-houses, liable to registry and inspection, where persons are lodged for a single night or less than a week. Unless some exception be made for Brighton, Margate, Gravesend, and other watering places, the inconvenience and annoyance will be great; as house-holders are glad to accommodate visitors who run down by steamboat or rail on the Sunday, and return on the Monday.

The clause 54, giving control to the commissioners for regulating the levels and plans of new streets, is arbitrary in its interference with private property, while six weeks is very much too long for any inquiry to be made by a local board or its officers.

In the next clause, 30 feet is too wide for a mews; 24 feet is ample.

The clause 58, for enabling local boards to set up waterworks, however necessary in itself, is likely to do evil by throwing impediments in the way of private enterprise, for the existence of any company to be set up is precarious and dependent on the local board.

After all that has been said about graveyards in towns, it is a pity to see the countenance given to this abuse by clause 67, which allows of graves being made with only thirty inches of soil over the coffins,—a shameful and fearful nuisance.

The clause 78 is inconsistent with the general tenour of the act, for after making it compulsory on each house to have the water laid on, the measure of cutting it off for non-payment of rates, is one not favourable to the public health.

## REVIEWS.

*The Theory and Practice of Ship Building.* By Thomas White, jun. London: Johnstone, 1848. 8vo. pp. 101, with volume of folio plates.

The science of ship building appears to us one of those in which the precise application of mathematics is not to be attempted; but of which, nevertheless, the leading principles should be based on the theoretical laws of mechanics. For ship building, mathematical formulæ can do nothing—mathematical principles everything. The former cannot take account of the thousand and one practical requisites of a good ship—the latter leave sufficient margin for the attainment of the needful qualifications; the former impose laws which are not always just, and even where they are just, are too minute and restrictive; but the latter establish a more liberal and lenient code—one more easy to be obeyed and more deserving of obedience. In choosing between a scientific principle and an analytical formula, the ship builder chooses between a friend and a master.

There is, however, a great difference between general principles and *vague* principles. It is the latter which are now almost exclusively observed in the public dockyards. Grave official personages have a great horror of matters whch they themselves do not understand, and consequently the range of their antipathies is very comprehensive. It includes science. It is no great scandal to assert that in the government dockyards, the most profound science is not so useful a personal commodity as kinship to one of the Lords of the Admiralty. Let a man prove by rigorous scientific demonstration, that some established rule of ship building is essentially erroneous—and will he be rewarded for his pains? Will he be thanked for making an advance in science? Will the obligation under which he has laid society to him, be discharged? Quite the contrary. The chances are, that he will be frowned down as a visionary, or rebuked for pretending to know more than his betters. In the eyes of men in office, to be set right is to suffer *lese-majesté*.

There is one chance, however, that a scientific discovery may be useful, if not to the discoverer, at least to the public;—some one who dines occasionally at the Admiralty, may think it worth while to appropriate it.

Our respect for government science, for the researches of royal commissions, the mathematics of blue-books, and the investigations of official inspectors, is extremely limited. In matters of experimental philosophy, we should lay it down as a general rule, that the persons least likely to find out the truth are—the "properly constituted authorities." What a satisfactory affair the Gauge Commission turned out! How well Sir William Symonds' ships sail! With what universal and unhesitating deference did the railway engineers receive the reports of Sir Charles Pasley! And to go still further back, how admirably the Irish Railway Commissioners executed their task! of which the most favourable thing that can be said is—that their report suited the character of the country affected by it. The blunders of admeasurement in the plans and sections were not *much* more egregious than some which have been detected by the Standing Orders committees: and Mr. Barlow's investigations of the effect of gradients are not very much worse than a mathematical student would write in his first year.

It seems to us quite clear, that for the future advancement of the practical sciences we must trust entirely, or almost entirely, to private efforts. At rare intervals, indeed, a commission will be competent for the scientific investigation assigned to it: it is reasonable, for instance, to expect much benefit from commissioners selected as those appointed to consider the use of cast-iron girders on railways have been. But on the whole, these cases must be looked upon as exceptions and happy accidents. In naval matters the inefficiency of official philosophy is especially deplorable, because of the enormous expense which it entails upon the nation. After all the visits of the Lords of the Admiralty to Portsmouth —after all the parliamentary returns and parliamentary debates—after all the enormous cost of ships built on new models, to be subsequently remodelled and patched as the prevailing caprice dictated—after all the exploits of experimental squadrons—we have come to the very gratifying conclusion that our most weatherly vessels were taken from the French in the late war. O, for an *Ecole Polytechnique* in England!

The author of the work before us professes no more than "to give some plain directions for actual building," and to put the reader in possession of just so much information as is requisite for carrying him to "larger and more scientific works on the subject." But the present treatise, though it does not aim at extreme profundity, has the greater merit of expressing in simple terms some very important views respecting the application of hydrostatics to the theory of ship building. The *stability* of a vessel is properly insisted upon, as a perfectly indispensable requisite—one without which all other merits are valueless. The form of a vessel may enable her to sail fast, but if, at the same time her pitching and rolling motion be excessive, the practical utility of the vessel is proportionably lessened, her security endangered, and her durability diminished by the constant strains to which she is subject. Sir William Symonds' vessels are, our author remarks, liable to these grave objections. In his vessels, the rake of the stem is sometimes so great, that the stem is inclined to the keel at an angle of thirty degrees. By thus cutting away, so to speak, a large portion of the fore body, it is clear that when the vessel pitches ahead, there is less immersion or sustaining power to bring her up again, than there would be if the stem were more upright. He committed a similar error with respect to the lateral rolling. The lateral stability, of course, depends in a great measure on breadth of beam; but the general form of section amidships must be duly proportioned in reference to it. "Here," says our author, "we consider, is to be found the great defect in the surveyor's midship section; it is comparatively straight from the keel to the water-line; and, as such, is manifestly deficient in bearing, until its extreme immersion takes place, which is sudden almost to a jerk; whereas a rounder line would prevent the great degree of lateral inclination, and what must take place would be much more easy. The advantage of this, in comfort upon the deck, efficiency at the guns, wear and tear of the rigging, and indeed, the safety and comfort of the whole, must be apparent."

The conditions of stability, either laterally or longitudinally, are not after all so very difficult to ascertain. The problem is practically a hydrostatical, not a hydro-dynamical one, and therefore much easier than that of determining the forms best adapted for speed. If navy surveyors had only a moderate acquaintance with the properties of the METACENTRE—if their appointments depended rather on their knowledge of hydrostatics, than on their government influence, or aristocratical connections, we should have to pay for much fewer of those great wooden coffins which now disgrace our navy. As far as we may judge from Sir William Symonds' actual performances, he either does not know the meaning of the word "metacentre," or he cannot have studied its properties. He may possibly have an idea that they have some influence on the stability of a vessel—but he certainly cannot know that they are, not merely important, but all-important—that in the question of stability, the properties of the metacentre constitute the question, the whole question, and nothing but the question.

Mr. White's practical directions we will not venture to criticise at length. The accuracy of his general views, however, and his long experience in his profession, seem just grounds of dependence on his authority in matters of detail. The folio plates are carefully drawn and admirably executed: and the descriptions which accompany them are very minute, and appear well suited to the purposes of the ship builder. The work concludes with an account of the methods now in use for measuring tonnage, and with remarks on the complexity and inefficiency of the new method established by law. We conclude with the following brief extracts, the first selected for its scientific importance, the second for its curiosity:—

> "The form of body best adapted for steam vessels, is a primary consideration. It will be found that most of the principles which constitute a good sailing ship, will also apply to a steamer. We have repeated instances, in which first-class steam ships that have afterwards proved of superior character, have gone as fast, under jury rig, and with not more than half the momentum of canvas allotted to sailing ships of equal tonnage, as they have subsequently gone under the full power of the engines. Many valuable inferences may be drawn from this fact; and we unhesitatingly bring to our aid, in building steam ships, the whole experience of the profession, to a much greater extent than was at first adopted. Experience shows that the long bow and clean run are indispensable; for, whatever may be the laws of fluids, the great speed of river boats thus built, the increase obtained by lengthening so many of the earlier formation, and the increased acuteness of each succeeding class, amount to a demonstration on this point."
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> "The ark in Scripture was of these proportions, namely, six times the breadth for the length, and one-tenth the length for the depth. Other proportions may in particular circumstances promote speed; but for stability and security at sea, the proportions of the ark, destined as she was to endure the greatest commotion of waters the world has ever known, are, we fearlessly assert, infallible, since the experience of four thousand years has only confirmed them; a collateral evidence, at least, of the truth of the Scripture narrative. The ark was twice as long, and twice as wide and deep, as the West-India mail steamers, and consequently would make eight of them, considered as regular figures."

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*An Historical, Practical, and Theoretical Account of the Breakwater in Plymouth Sound.* By Sir JOHN RENNIE, F.R.S., F.S.A., F.G.S., President of the Institution of Civil Engineers. London: Bohn and Weale, 1848.

Sir John Rennie could not have more worthily devoted himself than to the commemoration of the great work of his father, the Plymouth Breakwater, and he could not have erected a monument more munificent than the volume now before us,—one which while it records the merits of his father, and gives proof of his own enlightened spirit, will be of value to the engineering profession for many generations. Well may we describe it as a monument more lasting than brass, while it bears a more noble inscription than was ever sculptured on marble. Of Sir John Rennie's works we will not speak, for others can put forward a claim to the production of works of equal magnitude and merit, but we cannot refrain from saying that this book is another public service rendered to the engineering profession. As President of the Institution of Civil Engineers, Sir John has upheld the social rank of the profession, and has maintained its public hospitality; by the contribution before us, he has shown his earnestness in the cause of professional literature. These are to our mind merits in addition to the material monuments of his skill, and speak powerfully of his enlarged and liberal mind, and of his public and disinterested spirit. They show that his heart and soul are engaged in the career he pursues, and are a guarantee of his professional independence and integrity.

We speak warmly, because it is rarely we have the opportunity of speaking of a book from the hands of one of the higher members of the profession, and therefore it comes more welcome to us. It is true there are excuses for the silence of those members, and Sir John has himself very well explained them, but that does not exempt us from our duties towards him, who stands a brilliant example of successful exertion. Sir John Rennie's words merit attention, for they must be the exculpation of our engineers in the eyes of Europe. He says—

"Continental engineers have generally more time than English engineers for writing and reflection. The former, confined for the most part to a single work at one time, have leisure to study and reflect upon every operation connected with it, and to deduce general laws from them which may be applicable in similar circumstances. Their sphere of action nevertheless is limited, compared with that of English engineers, and they have not the same facilities of acquiring that readiness of application, that versatility of inventing remedies to meet every case which occurs in practice, and which alone can be derived from extensive and greatly-varied experience in all kinds of works, such as falls to the lot of English engineers. This defect is necessarily inherent in the continental system, notwithstanding the numerous able engineers we find there. The whole of the works, as well as the engineers, being in the employ and under the control of the government, their energies are impeded, their talents are fettered, and they are deprived of that strongest of all inducements to exertion, viz., competition, which has been productive of so much benefit in this country. Here, as regards engineering, everything has been free and untrammelled; thus every member of the profession has been at liberty to study and follow out that course which appeared to him best calculated to acquire public favour, and secure his own interest; and the public, on the other hand, has never found any deficiency of talent to carry out any work as often as the emergency required.

The government also have equally profited by this system, for they can always enter the market upon the same terms, and obtain any degree of talent they may require without the necessity of training a corps of civil engineers of their own, which, for the reasons above stated, would be found very difficult, and perhaps not without entailing the expense of numerous failures, which is the more unnecessary, as they can obtain the experience ready-made without any such sacrifice. Nearly all the great works and improvements in the public establishments have hitherto been obtained in this manner; of which the Breakwater and many others may be termed excellent examples, and by pursuing the same system, the same beneficial results will continue to be produced. On the continent the superiority of our free system of competition is in many cases much admired, and will probably be introduced where circumstances render it practicable; and English engineers are highly esteemed and much employed on the continent."

This is spoken fairly, and Sir John takes care that he shall not be understood as speaking invidiously, or as depreciating the continental engineers. He says—

"In saying thus much, I wish to be distinctly understood, that I should be extremely sorry to be considered as undervaluing in the smallest degree the numerous able engineers in every department on the continent, or the magnificent works which have been constructed by them, or the excellent books they have written, which have been productive of so much benefit to the profession of civil engineering."

In these sentiments we fully concur; we honour our continental brethren, but we demand for them as for ourselves the benefits of what we believe to be a better system—that of the competition of civil engineers. We advocate for their interests a wider field of exertion, and emancipation from the thraldom of the government bureaucracy, protection for men of ability, and no false encouragement for men of no ability.

In expressing himself thus boldly, Sir John Rennie has done very great service to the profession by vindicating it from the injurious and insidious designs of the government here, who are always seeking to establish military engineers in capacities for which they are utterly unsuited. We wish other members of the profession of equal reputation would display the same dignity of feeling and disinterestedness, by publicly expressing their unfavourable opinion of the government assistance. We hope the fear of losing some small amount of government patronage does not keep them back from doing what Sir John Rennie has unhesitatingly expressed.

We wish too they would imitate him in the production of books, such as his. At any rate, their pecuniary means enable them to imitate him in the lavish outlay he has made on drawings and engravings. They have the drawings in their own offices, and if they merely put them in the hands of the engravers, without any text, the plates will prove of value to professional students. We have seen so many examples of liberality among the profession, that we hope it will be equally displayed in contributions to engineering literature. Money only is required, their time is not required; and though they can plead they have so little of the latter, they have been well enough rewarded to deprive them of such a plea in the expenditure of money.

We have been apt to adduce as a merit in professional works that they were profusely illustrated, and we believe our readers will agree with us, for such books are thereby of a more practical nature. In this respect, Sir John Rennie's volume has few to surpass it; and it is undoubtedly one of those great works, which must at once take its place in the standard library of engineering. No expense has been spared, we may say no care has been spared, to make that portion of the work complete which speaks to the eye, illustrating the words of Horace—

> "Segnius irritant demissa peraures
> Quam quæ sunt oculis subjecta fidelibus"

The eye of the practical man seizes at once the construction and proportions in a drawing, while the most copious description fails to convey an impression so complete. Again, it is more easy for those who wish to copy a good example to do so from a drawing than from a description, and when we consider that a work of this kind is to be a text-book for hundreds of engineers, it appears most desirable that it should be, as it is, really and truly useful.

On leaving the presidential chair, Sir John Rennie has not retired from the public service. He never could retire into obscurity, but he could well have claimed exemption from further contribution. That he has completed this magnificent work gives him an additional title to future fame, as it does to the gratitude of his contemporaries for his maintenance of the dignity of their profession.

*The Young Surveyor's Preceptor.* By John Reid, Surveyor. Parts I. and II.

The object of this work is to explain the present system of measuring and estimating builders' work;—for this purpose the author has given the plans of a first-rate building, and explains how the measurements are taken, commencing with the digger, and going on with the bricklayer and carpenter. The dimensions are all given in detail as taken off in estimating, and are accompanied with a specification of each trade. Mr. Reid appears to have adopted the practice of the most experienced surveyors, and has produced a work which is likely to be of great benefit to the pupil, in *assisting* him in his professional pursuits. In saying this, we must caution him not to imagine that he can obtain a sound practical knowledge of the duties of a surveyor or architect, from merely reading or studying this work, or any other book or lecture: it can only be attained by accompanying an experienced surveyor in measuring or making an estimate of the building itself.

## PROCEEDINGS OF SCIENTIFIC SOCIETIES.

### INSTITUTION OF CIVIL ENGINEERS.

*Feb.* 22.—Joshua Field, Esq., President, in the Chair.

The paper read was by Mr. A. Mitchell, of Belfast, Assoc. Inst. C.E., "*On Submarine Foundations; particularly the Screw-pile and Moorings.*"

Considering that the entire subject of the various sorts of piling, of solid stone foundations, of cofferdams, of masses of concrete, and the numerous modes adopted by ingenious men for overcoming local difficulties, would occupy too much time, and scarcely possess novelty, the author restricted himself almost entirely to the description of the works executed by him with the screw-pile, as that had been chiefly employed for supporting structures on loose sand or mud banks, wholly or partially covered by the sea, where it had been previously considered very hazardous, if not impracticable, to erect any permanent edifice; and in his narrative, he scrupulously avoided all comparison with other modes of proceeding, even when they had the same object. The origin of the screw-pile was the screw-mooring, which was designed for the purpose of obtaining, for an especial purpose, a greater holding power than was possessed by either the ordinary pile or any of the usual mooring-anchors or blocks, of however large dimensions. It was proved by experiment, that if a screw, with a broad spiral flange, were fixed upon a spindle, and forcibly propelled by rotary motion to a certain depth into the ground, an enormous force would be required to extract it by direct tension; and that the power employed must be sufficient to drag up a mass of earth of the form of the frustrum of a cone reversed—the base being at the surface of the ground, and the section of the apex being equal to the diameter of the screw. The extent of the resisting mass must, of course, depend upon the natural tenacity of the soil. Even in this reasoning, it must be evident that a vertical force was calculated upon; but as, practically, that seldom if ever occurred, the angle of tension and the curve of the buoy-cable again gave the moorings greater power. This was found to be correct in practice, and the application of the moorings became very extensive. An arrangement was made with the port of Newcastle-on-Tyne, by which, for the sum of 2,500*l*., the right of fixing these moorings in the Tyne was given; and Mr. Brookes, the engineer, showed that last year, whilst in the neighbouring port, damage was done to the shipping to the extent of nearly 30,000*l*., no injury was sustained in the Tyne, entirely owing to the sound holding of Mitchell's screw-pile moorings. It naturally occurred to Mr. Mitchell, that the same means of resistance to downward pressure might be used; and he proposed to apply it for the foundations of lighthouses, beacons, and other structures, which, for maritime purposes, it might be desirable to place upon sand and mud banks, where hitherto it had been considered impracticable to place any permanent edifice. In the year 1838, a plan for a structure of this nature for a lighthouse, on the Maplin Sand, at the mouth of the Thames, was laid before the corporation of the Trinity House, supported by the opinion of James Walker, Esq., their engineer. The nine iron piles, 5 inches diameter, with screws 4 feet diameter, were accordingly driven 22 feet deep into the mud, and, with proper precaution, they were allowed to stand for two years before any edifice was placed upon them. The lighthouse was subsequently constructed, and, as was testified by Mr. Walker, had stood perfectly until the present time. Pending this probation, it was determined to erect a lighthouse to point out the entrance to the harbour of Fleetwood-on-Wyre, and under the advice of Captain Denham, R.N., the screw-piles were adopted. The spot fixed on was the point of a bank of loose sand, about two miles from the shore; seven iron piles, with screws of 3 feet diameter, were forced about 16 feet into the bank, and upon them timber supports 48 feet in vertical height were fixed to carry the house and lanthorn. This structure was completed in six months, and was perfectly successful, never having required any repairs to the present time. A similar lighthouse was erected near Belfast; and since then several others, with a great number of beacons, have been fixed in situations heretofore deemed impracticable.

A project was started by the Earl of Courtown, in the year 1847, for adding to the length of the pier at the Harbour of Courtown, on the coast of Wexford, which had proved an entire failure, from the channel between the solid pier being continually choked up with sand. Iron piles, with screws of 2 feet diameter, to be driven from 11 feet to 15 feet into the sand, and blue clay, were decided to be used in order to form an open jetty through which the sand could be washed by the current, and the platform would be used for loading and discharging the shipping. The surf was so heavy on the coast that the usual barges or floating rafts could not be used for putting the piles down—so an ingenious plan was designed by Mr. Mitchell, for projecting a stage forward from the solid part, rigging a large grooved-wheel upon the top of the pile, passing an endless rope-band around it, and round a pulley fixed 150 feet back, and then, by a number of men hauling upon the band, a rotary motion was communicated to the pile, which screwed it down very fast. By these means one bay of the pier, 17 feet long, was finished daily, even in very rough weather. The entire length of the jetty was 260 feet, its breadth 18 feet, with a cross-head 54 feet long, with landing stages at each end, and two lines of railway throughout. The entire cost of this extension was 4,150*l.*, or about 47*l.* 10*s.* per lineal yard—an extremely small sum compared with the cost of stone piers; but even that was more than the expense would be now, as the system of work is better understood, and materials are now cheaper. The account of the difficulties incurred in the execution of these works was most interesting, and ample testimony was borne by engineers of eminence, and men whose maritime experience gave weight to their opinion, of the superiority of Mr. Mitchell's screw-piles and moorings over every other system for holding buoys, or for supporting beacons and lighthouses, and their use was suggested for the foundation of bridges, viaducts, and numerous railway and other works, as well as a multiplicity of applications which had not hitherto been thought of.

Mr. W. A. Brooks gave an account of the method of laying down the moorings at Newcastle-on-Tyne, under his directions. A heavy chain, formed of 3¼-inch round iron, in links of 3 feet long each, was stretched along the bed of the river, in the direction of the current. To this chain, beneath each tier, was attached a 2½-inch mooring-chain, fixed to the head of a screw mooring; another screw being also placed beneath each tier, and driven down between 10 and 20 feet into the clay, and sometimes full a foot into the shale rock. The screws were 4 feet in diameter, and were placed in depths varying from 15 feet to 24 feet at low-water spring tides. They were screwed down to the depth of 15 feet in an hour and a half, and sometimes 21 feet in two hours. Each mooring screw was intended to have borne the strain of four heavy ships; but, during the last winter, the port was so crowded, that more than double the proper number of vessels were moored upon each; and yet there were no signs of weakness; and whilst nearly 30,000*l.* of damage was done at Sunderland, during a heavy storm, no casualties occurred at Newcastle, which Mr. Brooks stated was entirely owing to the sound holding of the screw moorings. He argued, therefore, that the small sum of 2,500*l.*, paid by the harbour commission of Newcastle for the right to put down these moorings, was a very wise expenditure.

Mr. T. Smith, Pilot Master of the Port of Shields, corroborated Mr. Brooks's statement.

Captain Washington, R.N., had, in the course of his surveying duties, seen the screw moorings in almost every position, and had heard them universally eulogised, as being the best and safest moorings hitherto known. He strongly recommended their employment. He had also examined carefully the screw-pile lighthouses, and had every reason to be satisfied with them, as affording a means of placing lighthouses and beacons where they were before impracticable, and enabling floating lights to be generally superseded by fixed lights, which latter he proved, from documentary evidence, to be one-third less annual cost than the former, and certainly more useful to sailors; for, in spite of all the care, attention, and even lavish expenditure of the Trinity Board to moor the lightships securely, they did go adrift just at the time when they were most required. He, therefore, advocated fixed lights in every situation where a foundation could be obtained; and he believed that, with the screw-pile, there were scarcely any situations where this could not be accomplished.

Messrs. Walker, Cubitt, Rennie, Murray, Moorsom, Mitchell, Scott Russell, and others, took part in the discussion, adducing instances of the efficiency of the moorings and the piles, and of their applicability to numerous engineering works, for which they expressed their intention of employing them. The high price hitherto charged for the right of using them had somewhat retarded their general introduction; but it was explained, that Mr. Mitchell had feared to entrust to others the fixing of them, lest a failure might ensue before his system was perfected, which, however, he now thought it was. Now, however, as the right of granting licenses for their use was transferred to men of business who had purchased it, there was no doubt of their being brought within the reach of every application.

*Feb.* 29.—The paper read was entitled "*Remarks on the Formation of the Entrances to Docks, situated upon a Tideway.*" By Mr. J. B. Redman, M. Inst. C.E.

After illustrating the subject by the example of the position and direction of all the principal dock entrances on the borders of the Thames in the port of London—showing that the variation in the opinions and practice of engineers had been very great—the paper detailed the ordinary methods of docking and undocking ships, and the precautions to be taken in constructing entrances, which should be best adapted for facilitating these operations; and, although it was difficult to lay down any positive rules upon the subject, as the engineer must, in almost every case, be guided by local circumstances, yet in ordinary cases the following general rules were recommended:—For graving docks, an angle of about 45°, pointing up the stream; for wet docks, an angle of about 60°, in the same direction; and a right angle, with the stream, for building ships. These, it was believed, would be generally found the most available.

*March* 7.—In the discussion upon Mr. Redman's paper, the merits and defects of the several dock entrances in the Thames and in other situations were examined, and the general result appeared to be, that although the engineer must be guided by local circumstances, yet, that in situations where the river was sufficiently wide, and the position of the land permitted, an acute angle pointing up the stream, was the best for docking vessels with the flood—that the reverse would be best for undocking ships. In ordinary widths of rivers, therefore, the end would be attained by forming a bay sufficiently deep to render the water still in front of the dock, the wing walls being so much splayed as virtually to give the directions up and down the stream as circumstances required. The peculiar positions of the docks at Ipswich, by Mr. Palmer, the alterations of the Duke's Dock at Liverpool, by Mr. Cubitt, and other cases, were sustained in support of the arguments of the speakers, who all united in praising the industry and talent of Mr. Redman, in bringing forward the subject in the complete manner he had done.

*March* 14.—The paper read was "*An account of the effect of the Storm of the 6th of December* 1847, *on the coast near Edinburgh, as illustrating the Principles of the Construction of Sea Defences.*" By W. J. M. Rankine.

The principal example given was the sea wall of the Leith branch of the Edinburgh and Dalkeith Railway, built by the author in the year 1837, from Mr. Walker's designs. Just after it was completed, a violent storm occurred, which injured almost every similar work within its range, but produced no ill effect upon that structure. On the 6th of December 1847, a still more violent storm occurred, which did great damage all around, but the railway wall still escaped without injury. The total length of the wall was about 760 yards; its height was 13½ feet above the beach at the highest point, diminishing to about 6 feet at the ends. The height of the top was 4 feet above equinoctial spring tide level. Its least thickness was 5 feet and its greatest 10 feet; the back was vertical, but the face had an inclination at the lower part of 5 inches in the foot, gradually becoming curved as it rose upwards, until at the top it overhung slightly. The foundation course was composed of large flat stones, laid horizontally 4 feet below the surface of the beach, upon a stratum of fine sand and gravel, firm when dry, but moveable when wet. The face was of hammer-dressed ashlar, about 2 feet thick; the back of rubble, 18 inches thick. The interior was filled with concrete. The coping was composed of stones each weighing about half a ton, connected by means of cast-iron dowels. The stone used was Craiylieth sandstone. The face joints were laid in cement for a depth of 4 inches. The foundation was protected by a pitching of trap boulders, laid on the natural level of the beach. They were partially disturbed by the storm referred to, and the author ascribed this to their weight being insufficient to resist the vertical oscillation of the waves.

The second example was a vertical sea wall near Trinity, the foundation of which was protected by a dry stone bulwark sloping at angles of from 30 deg. to 40 deg. The wall was injured by the the storm, but the pitching was breached at several points.

The third example was another wall near Trinity, of a hyperbolic section. The lower part had a slope built dry up to a little below high-water mark. At this point there was a sharp curve, and the upper part was nearly vertical, and laid in mortar. The waves extracted the stones of the curved portion, and the upper part, being undermined, was destroyed to a great extent.

The last example was the bulwark of the Granton line, the lower part of which sloped at about 20 deg.; the upper portion was curved, and was covered by a heavy projecting stringcourse and parapet. It was built dry, and the stones of the lower part weighed not less than half a ton each. This bulwark suffered damage to a slight extent on its upper portion.

These examples were stated to confirm the following principles:—That the principal action of the waves in front of a sea wall was a vertical oscillation, produced by the combination of the direct and the reflected waves; that a sloping bulwark gave rise to a sloping oscillation, tending to overturn any portion which projected above the line of slope; that where the strength of a sea wall depended on the pressure of the superincumbent masonry, and the adhesion of mortar and cement, the position of greatest stability was vertical; and that when the strength depended on the weight of the individual stones, the position of greatest stability was a very flat slope.

In the discussion which ensued, instances were adduced of the duration of vertical walls under the attacks of heavy seas, and, on the other hand, of their destruction when flat slopes had effectually resisted the waves; and it was agreed that in this, as in all other cases of engineering, no empirical rules should be laid down, but that the skill of the engineer should be exerted to adopt such forms of construction as were best adapted to the locality and the circumstances.

*March* 21.—The discussion on Mr. Rankine's paper was continued. Letters were read from Mr. Maclean, describing the Barras and Piel sea embankments; and from Mr. Macdougall Smith, on the importance of using stone of great specific gravity in sea-works.

Mr. Bateman stated the necessity of using hard and tough stones, which would resist disintegration by the friction of the shingle moved by the waves.

Mr. Murray corroborated the statements of Mr. Bateman, and recommended groynes as the best means of collecting sand and gravel, to protect exposed coasts, and the foundations of sea-works.

Mr. Rankine replied to some of the remarks which had been made. He referred to Mr. Scott Russell's paper on sea walls, as being partly confirmed by his observations. He disavowed the intention of laying down universal rules for the construction of breakwaters in deep water, from observations on walls built on a flat beach; but, to show how the principle of such walls could be applied, he referred to the Cherbourg breakwater, where the top of a stone embankment formed an artificial beach, on which a vertical wall was founded.

The paper read was descriptive of "*A Method of Setting out a Railway Junction.*" By A. Beaulands.

The object of the paper was to supply a methodical rule for setting out that portion of a branch line of railway included between the rails of the main line. The author observed, that in all ordinary cases the curve of a branch line could not be set out from the main line, which was supposed to be straight, by the ordinary methods of setting out railway curves, since the junction was required to make an offset of 4 to 5 inches on the length of the switch-rail, which was much greater than the offset made from the tangent in the same length by a curve of moderate radius, so that it was necessary to make the junction line start abruptly at a finite angle with the main line. He, therefore, considered the junction-curve, to be determined by its passing through three given points—namely, the two extremities of the switch-rail, and the furthest point of crossing; and from these data, he showed how the radius and centre of the circular arc might be found, as well as the positions and angles of the various crossings. To render the method more easy of application, the author gave a table, calculated from the principles and formulæ laid down in the paper, assuming an ordinary form of the switch, and a series of valves of the lead, a distance of the furthest crossing extending to the greatest limit likely to occur in practice.

In the course of the discussion which ensued upon this method, as compared with the ordinary system of setting out junctions by a comparatively empirical rule, well understood and practised by the platelayers on railways, Mr. Wyld's switch was alluded to, and exhibited. In this switch all notching and inequality in the bearing surfaces of the fixed rails were shown to be avoided, by the ends of the tongues being housed under such surfaces, instead of being notched into them: the tongues being consequently at their points, and for some distance between them, lower than the fixed rails, exercised when they were weakest merely a lateral action against the wheels, without bearing any of the weight of the passing trains. Several engineers who had employed these switches extensively, expressed themselves relative to them in very commendatory terms, and stated that they were not only manufactured in a very superior manner, but that their action was very perfect, and that they tended greatly to the prevention of accidents in railway travelling.

## ROYAL INSTITUTE OF BRITISH ARCHITECTS.

*Feb.* 21—The Earl de Grey, President, in the Chair.

Mr. G. Bailey, the honorary secretary, read the report of the council relative to the medals for the session 1847-8.

With reference to the Royal Medal, it was stated that, in pursuance of notification in the various publications, English and foreign,—"On the 31st of January, 1848, the council met to receive nominations and applications of candidates, when sixteen names (eight Englishmen and eight foreigners) were given in and considered. The meeting being adjourned to the 14th of February, the claims of the several candidates were further considered; and a ballot being taken, the majority of votes were found to be in favour of Mr. Cockerell; and it was accordingly—'Resolved, That the Royal Medal of the Institute be awarded to Charles Robert Cockerell, Esq., R.A., Professor of Architecture in the Royal Academy of Arts, London, Member of the Royal Institute of France, &c., in testimony of his distinguished merits as an architect.'

For the Silver Medal of the Institute, offered for the best essay 'On the application of sculpture and sculptured ornament to architecture, and the principles which should regulate their introduction into buildings generally, both with regard to beauty of embellishment and propriety of style,'—Three essays have been received, distinguished by the following mottos: No. 1. '*Junius*;'—No. 2. '*Rule*;'—No. 3. '*Nisi utile est quod faceinus frustræ est gloria.*'

The three essays display much ingenuity and a praiseworthy habit of observation; they contain many judicious observations on the higher branches of sculpture, but in general the remarks are too indefinite, and are deficient in the illustration derivable from immediate reference to examples.

The authors appear to have mistaken the immediate aim of the question proposed:—the subject is of a practical and positive nature, in relation to a specific architectural purpose, and was not intended to elicit a disquisition upon the abstract attributes of sculpture.

Sculptured ornament, a most important section of the programme, appears in two of the papers to have totally escaped the attention of the writers, and in the third is only casually alluded to.

The council, however, are of opinion that the author of the essay headed '*Junius*' has evinced considerable talent, and that he is justly entitled to the medal offered.

For the Soane Medallion, the subject being 'A design for a building to contain public baths on a comprehensive scale, with all suitable accessories, and combining the magnificence of the ancients with the usages and puposes of modern times,'—Five designs have been received:—A. Four drawings and MS. description, motto '*Quod potui perfeci.* No. 1.'—B. Four drawings, motto '*Quod potui perfeci.*'—C. Six drawings, motto '*Ne nimium ex-pectes annis prudentiæ crescit.*'—D. Three drawings marked '*Aquarius.*' —E. Two drawings and MS. description, marked '*Christophorus.*'

The council cannot refrain from noticing the little attention which appears to have been given by some of the candidates to the printed conditions, and particularly as respects the adaptation of the buildings, 'to the usages and purposes of modern times.'

Although the several designs are formed on a scale sufficiently comprehensive to embrace all imaginable as well as suitable accessories, in some no indication is given of provision being made for the varieties of medicated or other baths so much in use at the present day; nor reservoirs, nor the requisite apparatus for heating the large quantities of water that would be required to supply such extensive warm and tepid baths as are shown in the drawings; neither are chimneys or shafts provided to carry off the smoke, steam, &c., which it would be impracticable, under any circumstances, to consume.

The council are of opinion that the design marked '*Christophorus*' possesses, on the whole, the greatest degree of merit, notwithstanding the unfavourable manner in which it is represented in the drawings of the elevations and sections, and sufficient to justify the bestowing on it the award offered."

The author of the essay marked "*Junius*," is Mr. Henry Bayly Garling, associate; and of the design marked "*Christophorus*," Mr. James M'Laren, of Edinburgh.

Mr. Penrose read a paper "*On some of the Geometrical Lines and Optical Corrections of the Greek Architects*," which will be given next month.

*March* 6.—C. Fowler, V.P., in the Chair.

A paper was read, "*On the Ancient Buddhist Architecture of India.*" By J. Fergusson, Esq.

Mr. Fergusson commenced by showing that the generally assumed primeval antiquity of Indian buildings was not borne out by facts; as the oldest monuments in the country, whether cut in the rock or structural, belonged to the Buddhists, and the founder of that religion died only 543 B.C.: and that even that date was too early, as it did not become the religion of the state till after 250 B.C., in the reign of Asoka,—by whom the earliest monuments hitherto found in India had been erected. After showing that there was no real similarity between the architectural styles of Egypt and India, he proceeded to point out that the latter country was occupied by two distinct races of people,—the one aboriginal, and occupying the southern portion of the Peninsula; while the other, or Indo-Germanic race, came into the country, at a tolerably recent period, as conquerors or colonists, and settled in the valleys of the Indus and Ganges. It was among the latter race that the Buddhist religion arose and flourished for more than a thousand years, or from before 250 B.C. till after 750 A.D.,—though at the time of the Mohammedan invasion it seems to have been entirely extinct; and now there was not a Buddhist, or an institution of that religion, in the country of its birth. After alluding to the curious fact of the names of Ptolemy Antiochus, and other Greek kings, being mentioned in the inscription of this Asoka, Mr. Fergusson dwelt for some time on the existence of a purely Greek honeysuckle ornament being found on the pillars set up by this king at Allahabad, and on which one of his inscriptions is engraved. He then proceeded to classify the religious edifices of the Buddhists,—dividing them into three classes, the first being the Topes, or Dagobas, large domical buildings erected to contain relics, many of which still exist in Afghanistan and Ceylon as well as India. After describing the various parts of a dagoba, Mr. Fergusson showed how the tee, or ornament on the top of them, gradually became taller and taller, till it became a three or nine storied tower, not only in India, but in China,—as in the instance of the celebrated Porcelain Tower at Nankin. The circular inclosure of the topes was next illustrated, from a curious example at Sauchee, in Bhopal, which still retains its singular gateways. These likewise were shown to be the original of the Pailoos, or what are improperly called the triumphal arches of the Chinese. The next class of monuments were the Chaityas, or churches, which in India are known to us only from the caves; as are also the third class or Viharas, or monasteries,—which served as residences for the priests, and of which two or more are attached to every chaitya in every series of caves in India. After pointing out their general plans and arrangements, Mr. Fergusson proceeded to illustrate the beautiful mode in which the chaitya caves were lighted by one large opening or window over the entrance; and then explained the construction of the roofs,—which, though always circular in form, were never copies of arches (which were not to be found in India till long after the Mohammedan invasion), but of wooden construction; and in some of the earlier caves the original wood-work still existed, though in the more modern ones its forms were repeated in the rock. After concluding the Indian part of his subject, Mr. Fergusson pointed out the striking similarity that existed between the arrangement of the buildings he had been describing and those of Stonehenge,—which he had no doubt whatever was a Buddhist building; and he thought every part of that hitherto mysterious erection admitted of easy explanation on that supposition. He concluded by showing how domes were constructed in India; and pointed out the similarity that existed between the Indian examples and the well-known tomb at Mylasæ, in Asia Minor—and the curious circumstance that the hog-backed Lycian tombs, discovered by Sir Charles Fellows, strongly resembled, not only in form, but in construction, those Indian buildings which had formed the subject of the lecture; while the language of the inscriptions on them was a dialect of the Sanscrit, about as far removed from the mother tongue as that found on inscriptions in the Indian examples.

*March* 20.—Mr. Eaton Hodgkinson was elected honorary member, and Mr. Thomas Penson and Mr. Edmund Sharpe, M.A., fellows.

The honorary secretary announced the following as the subjects proposed for the medals:—

"Her Majesty having been pleased to grant her gracious permission for the *Royal Medal* to be conferred on such distinguished architect or man of science, of any country, as may have designed or executed any building of high merit, or produced a work tending to promote or facilitate the knowledge of architecture, or the various branches of sciences connected therewith, the council will in January, 1849, proceed to award the Royal Gold Medal to the *author of some literary publication connected with architecture.*

"*The Silver Medals* of the Institute will be awarded—

"1. To the best essay on the peculiar characteristics of the Palladian school of architecture, and a comparison and contrast of its elementary principles and details with those of ancient art.

"2. On the best manner of covering the roofs and forming the flats and gutters of buildings; the nature of the several materials used in various parts of the country for these purposes; their most effectual and economical application; the inclination to be given to the different parts, and the other practical precautions to be adopted to prevent snow and rain penetrating into the building.

"*The Soane Medallion* to the best design for a building to serve as a national repository and museum for the illustration and exhibition of the productions of the industrial arts.

"The successful competitor for this medal, if he go abroad, will be entitled to the sum of 50*l.* at the end of one year's absence, on sending satisfactory evidence of his progress and his studies."

Amongst the books presented were an essay, on "Cyclopean Walls" (*Kyklopischen Mauern,*) by Dr. Forchammer; parts of M. Daly's "*Révue Générale de l'Architecture,*" and of Mr. Fergusson's beautiful work on Indian architecture. The foreign secretary, in commenting on the donations, pointed attention to an article in the *Révue Générale*, complimentary to the Institute for not restricting the competition for the Gold Medal to this kingdom.

Allusion was made to the circumstance that all the impressions of Mr. Leitch's translation of Müller's "Ancient Art and its Remains" (of which a copy was presented to the Institute at the last meeting), had been destroyed by fire.

Amongst the letters read, was one from Herr Lange, of Fülda, acknowledging the honour of his election, and setting forth several subjects on which he could afford information, especially the Carlovingian monuments (eighth and ninth century), of his neighbourhood, and a collection of terms in use amongst the workmen of the middle ages.

Mr. T. H. Wyatt read a paper on the "*History, Present Condition, and Proposed Restoration of Llandaff Cathedral.*"

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## ROYAL SCOTTISH SOCIETY OF ARTS.

*Feb.* 28.—George Buchanan, Esq., F.R.S.E., President, in the Chair.

### ON CAST-IRON.

At the request of the council, an exposition "*On the Strength of Materials, particularly Cast-Iron and Malleable Iron, and their application in the construction of Railway Bridges* (Part I.)," was given. By George Buchanan, Esq., President.

On this subject, so important at the present time from the extensive use of these materials in the construction of bridges for railways, and from the new and extraordinary forms and dimensions which they are now beginning to assume, the council of the Society had requested their President to make a communication on the present state of our knowledge and practice, and this evening he read the first part of this communication, illustrating his subject by various interesting experiments and models, more particularly a large and beautiful model, with drawings and elevations, of the high level bridge across the Tyne at Newcastle, which, through the liberality of Mr. Robert Stephenson, the engineer of the bridge, he was enabled to exhibit, and to explain the situation, extent, and construction of this great work in all its details.

Mr. Buchanan began by stating that he did not profess to communicate anything new or original, but would be happy if he could only draw from the stores of information which had of late years been accumulating on this subject, under the hands of very eminent, scientific, and practical men, such leading facts and maxims as might prove a safe guide for our practice; and such truths, when they became known and established on the unerring grounds of experiment and calculation, could not, he thought, be too widely disseminated. The various strains might be all reduced to two kinds, according as the material is either distended or compressed by any force or pressure. From these two all others arise, and either consist or are compounded of them. The tensile strain is the simplest of all, depending neither on the peculiar form of the materials, nor even on the length, but only on a single element, namely, the Section of Fracture. This peculiarity of the tensile force was explained and illustrated. In regard to cast-iron, the result of the extensive and interesting experiments by Messrs. Hodgkinson and Fairbairn was given, and it was found from the mean of 16 different trials of English, Welsh, and Scotch iron, both hot and cold blast, that this material will sustain about 7½ tons per square inch before breaking, the weakest specimen being 6, and the strongest 9¾ tons. The limit of fracture, however, can never be approached with safety, not even within a long distance, seeing that this material is liable to unseen imperfections, and, above all, to snap in a moment without distending itself or giving any warning of danger. Malleable iron, again, is much superior in tensile strength, and, by its remarkable ductility, inspires confidence in a still higher degree; bears no less, at an average, by various experiments of Telford and Brown, than 27 tons—the weakest 24, and the strongest 29 tons; but, before the half of this load is applied, it begins to stretch, and continues stretching, up to the limit of fracture. It is, therefore, not only three times stronger than cast-iron, but may be safely loaded with five times the breaking weight, or about eight or nine tons.

In regard to the strength of compression, this depends also, as long as the length is limited, on the same element—the Section of Fracture; but when a long rod or slender pillar is loaded or compressed, it is liable to bend, not for want of strength, but for want of stability, the least flexure turning it off its centre, and breaking it by lateral force, deranging entirely the simple law applicable to short lengths. In regard to cast-iron, by far the most satisfactory experiments are those by Hodgkinson and Fairbairn. The mean result gives very nearly 50 tons on the square inch—the weakest 36½ tons, and the strongest 60 tons. It is thus six times stronger in compression than in distension, and hence it is peculiarly recommended for sustaining any superincumbent weight, as in the case of pillars and of bridges, provided the construction is such as to resolve the strain arising from the load into a longitudinal compression. This is often in our power by proper arrangements, chiefly giving a sufficient height and curvature to the arch; but in cases where, for the want of head-room, the arch is unduly flattened, or resolved into a straight beam or girder, the danger is that we bring the tensile force into play, and then the use of cast-iron is objectionable, or at least requires extreme caution. No direct experiments have been made on malleable iron of short lengths; but from some facts brought out by Mr. Hodgkinson, its strength appears much inferior to cast-iron, chiefly from ductility, whereby it gives way much sooner under a load. It will bear 27 tons, probably much more, without fracture; but with 12 tons it yields to the load, contracts longitudinally, and swells out laterally; and this is another very important fact for our guidance in the use of those different materials. In regard to stone, experiments have been generally made on specimens rather too minute. Like cast-iron, the crushing strength is superior to the tensile, and hence its adaptation for buildings, particularly bridges. Craigleith stone will bear 2½ tons on the inch, or upwards of 400 tons on the square foot; Aberdeen granite 600 tons. In regard to bricks, he had occasion to make experiments in relation to the great chimney of the Edinburgh Gas Works. It became matter of consideration whether the ordinary brick could withstand the pressure of so lofty a column. Trials were therefore made with a powerful hydrostatic press, not on small specimens, but on the actual brick. The ordinary stock brick was found to bear 140 tons on the square foot, and the common fire-brick 157 tons; but the brick of which the chimney is constructed, consisting of a mixture of fire-clay and ironstone, bore, a single brick on its bed, no less than 140 tons, equal to 400 tons on the square foot.

The effect of the transverse strain was then considered and illustrated by various experiments and models. This strain is a compound of the tensile and compressive strain, the one part of a beam loaded in the middle being compressed and the other distended, and the beam itself becoming a lever, and acting often with enormous power against its own strength. Hence it became easy to calculate the strength, this being in every case proportional in the first instance to the area of the Section of Fracture, and this original element modified by the length and depth of the beam, diminishing in exact proportion to the length, and increasing in proportion to the depth.

The transverse strain acting with such severe advantage against our materials, various methods have been contrived for eluding its effects, and of these none is more remarkable than the principle of the arch, the effect of which was illustrated by experiments, and particularly the necessity in flat arches of having secure abutments to resist the horizontal thrust, and this was frequently accomplished, where there is sufficient head-room, by uniting the extremities of the arch by strong malleable iron rods, in the same manner as in the case of the roof, the feet of the rafters are united and prevented from spreading by the tie-beams; and this is the principle, the securest of all, on which the great iron bridge at Newcastle, now in progress, is constructed the object of which is to cross the river and valley of the Tyne, on the highest level of the railways on each side, so as to unite them in one uninterrupted line from London to Berwick, and unite the termini of the different railways, now separated three quarters of a mile or more, into one grand central station, a little to the west of the ancient Castle. The distance between this station and the present terminus of the York and Newcastle Railway is 3,457 feet, consisting chiefly of the space occupied by the bed of the river Tyne, and the steep banks on each side, well known to travellers in descending from Gateshead Fell on the south, and Dean Street on the north, both to be now superseded by the smooth and level surface of the railway, and by a turnpike road running on the same bridge directly under the line of rails. The steep banks on each side are spanned by stone arches of a very substantial character, the river and low banks by six metallic arches, all of the same dimensions and structure, resting on solid piers and lofty columns of masonry. In the bed of the river the piers are laid on very solid foundations of piles and planking, with concrete, many of the piles 40 feet in length, and driven to this depth through hard gravel and sand till they reach the bed of freestone rock. Nasmyth's celebrated pile-driver is in full operation here, and with wonderful effect, and has come most opportunely in aid of the work; driving night and day, at the rate of 60 or 70 strokes a minute, the pile heads being often set on fire by the rapidity and violence of the blows of the ram. Piers laid 2 feet below low-water mark, and raised about 100 feet to the springing of the arches. The arches consist each of 4 main ribs of cast-iron, each in 5 segments bolted together, and forming one entire arch 125 feet span, and rising 17 ft. 6 in. in the centre, and the level of the rails on the upper platform 108½ feet above the level of high-water mark of the Tyne. Depth of the rib 3 ft. 9 in. at the springing, and 3 ft. 6 in. at the crown, with flanches 12 inches broad, external ribs 2 inches thickness of metal, internal ribs 3 inches. Total sectional area at the crown 644 square inches, which would bear with safety a load of 5,000 or 6,000 tons, and would form, with proper abutments, a strong arch in itself; but for the fullest security, and to prevent the possibility of inconvenience or risk from deflection or vibration, or otherwise, each rib is united at the springing by strong malleable iron bars or ties, 7 inches broad and 1 inch deep, of the best scrap iron, and in all 24 in number. The railway is supported above the arch, and the roadway suspended from beneath, by hollow cast-iron pillars 10 feet apart, and each 14 inches square, through which are passed strong malleable iron circular bars, binding the whole into one stiff and solid mass. The sectional area of the horizontal bars is 168 square inches, which would sustain upwards of 4,000 tons without breaking, and 1,500 tons with perfect safety, but the whole weight of the bridge will not exceed 700 tons, leaving 800 tons of surplus strength. The railway, which is at the summit level, runs on a level 4 feet above the crown of the arched rib, and is supported in the middle by hollow cast-iron trough girders resting on the top of the pillars 10 feet apart, and united by longitudinal timbers laid with strong planking. The roadway runs nearly on a level with the malleable iron ties, leaving a space of about 20 feet clear head-room.

In the whole of the work the utmost pains has been bestowed on materials and workmanship, and in making everything complete, the surfaces, which abutt together, being regularly planed or turned, as in machinery; and, from all the arrangements, the most successful results may be anticipated from this bridge. The cost of the iron work and roadway, by the estimates, comes to £112,000, and the contracts for the bridge and viaducts to something above £300,000.

## CONWAY BRIDGE, CHESTER AND HOLYHEAD RAILWAY.

We give the following details of floating the tubular bridge at Conway, on account of their highly interesting character. Next month we hope to be able to give full particulars of the raising of the tube and the machinery.

In sight of a large concourse of people, covering the whole space of the suspension-bridge, the towns and walls of the noble old castle, and the fields in the background of the spot on which it was built, the wonderful effort of science, the tube-bridge, was floated at 11 a.m., on the 6th ult., and moved from the piles and stays on which it was constructed, and fairly brought into the tide-way of the Conway, while its flood-tide was running at the rate of at least two miles per hour. It appeared to float with the greatest ease, and not immersing the six pontoons on which it rested (three at either end) to within at least 3 feet of their decks. The precautions taken by Capt. Claxton, R.N., to whose sole direction the transporting of this enormous mass was committed, were admirably contrived to keep the machine suspended over the fixed piers, to await, as it were, the decision of the engineer as to whether the perilous step of launching into the deep (for deep indeed is the river, 12 fathoms at low water) should be proceeded with, or whether the valves should be lifted, and the tube dropped, as it were, again in place, upon its piers—many circumstances appearing to bear upon that determination; the strength of the current; the height to which the tide promised by its comparative rising; and the strength of the wind. At about 11 a.m., however, the tide appeared to slacken, and the resolution was formed, for all at once the chains and ropes were hove upon, and in ten minutes it had pased that, the first Rubicon—gradually but steadily it approached the site intended for it. Mr. Stephenson, with Mr. Edwin Clarke and Mr. Brunel, accompanied Capt. Claxton, who directed the proceedings. He used two figures, of large dimensions, Nos. 1 and 2: when the red side was shown of the former number, a capstan fixed on the road from Conway to the tube works was hove upon; when the white side was shown the heaving stopped, and a similar operation with No. 2 governed the operations of a powerful capstan (lent by the Admiralty), fixed on the railway on the Chester side, with its rope made fast to the inside of the tube, on that end. In the pontoons three enormous masses of timber, 95 feet long by 25 feet wide, and 8 feet deep, bound together by powerful crabs worked by 44 men, hove upon the chains, which had previously been tightened up by a large crab, at which a dozen or more men strained with their utmost efforts at either end on shore, one end of each chain being fixed at the piers of the suspension-bridge, while the other ends were fast to the aforesaid crabs, on the opposite side of the river: on these chains the pontoons appeared to traverse. The western, or Conway end, was pointed first, but did not come quite home afterwards. The eastern, or Chester end, was dropped in after, or while the ebb was making; but before it reached by about a dozen feet the exact berth, it took the mason-work, and no effort could disengage it. Nevertheless, it was over its bed sufficiently to be landed and bedded up with timber previously prepared from a lower bed, which had been provided in case the tide should fall before the upper bed could be reached. The most extraordinary efforts were made with screws and tackles, no less than four of which latter were at one time applied, besides the Chester side crab, manned by 60 people, while the tide was falling, to overcome the obstacle; but they appeared to be ineffectual, and Capt. Claxton was heard to give orders for bedding up, which was speedily accomplished. The barges were then sunk a little, and the noble fabric rested very near the hydraulic presses which are to be used in raising it. Eighty men were in each set of pontoons—one set commanded by Capt. Dunce, R.N., an assistant of Mr. Brunel, and the other set by Lieut. Blatchley, R.N., the crews under them performing the principal work, being sailors from the "Home," of Liverpool. In the tube attending the hawsers, were the officers and some of the crew of the *Great Britain*. On the top, on the Conway side, Mr. Fairbairn, of Manchester, had the direction; and on the Chester side, Lieut. Glenny, R.N. The great difficulty to be overcome was apparent—the small space to play in—for on the Conway side it wants 9 inches, by actual admeasurement, of being home, or in place; while on the Chester side, it is fairly jambed against the masonry—so that in fact there were barely 9 inches free in 400 feet. No sooner had the tide fallen sufficiently than the obstacle to the exact fixing in position became apparent to all. The inner pontoon was butting at its end against and partly on a rock. It took the ground which had been blasted away from the solid rock in consequence of having got a little twisted previously to starting, we were assured full 4 feet. On the 11th ult., the tube was again floated by the pontoons, and was finally placed with its two ends resting upon the shelves of masonry constructed to receive it, prior to its being raised to the elevation at which it is placed, about 15 feet or 16 feet above. The lifting of this enormous mass of iron, which weighs about 1,300 tons, is to be effected by two hydraulic presses, with 18-inch rams, and pumps ⅜ of an inch diameter. These pumps are to be worked by steam-engines, which will give a pressure equal to 3 tons on the circular inch, or a total lifting power for each press of 972 tons, which, of course, will be amply sufficient for the purpose. Each press has a lift of 6 feet; and, as the ends of the tube rise, the masonry which is intended to support them will be carried up from the shelves on which they now rest.

## AUXILIARY STEAM-POWER FOR VESSELS.

Sir—In consequence of the great extension of railways, and the facility they give for quick transit of goods, they are operating seriously against the shipping interests and coasting trade; and unless some mode can be adopted by which coasting vessels can be made to compete with the railways, this trade will be completely destroyed, which will be a serious loss to many harbours, and also the mercantile interests of the country; as railways will obtain not only the light and best-paying goods, but also many of the more bulky articles, in consequence of the want of regular sailing traders.

I think it would be interesting to many of your readers who feel a deep interest on this subject, to ascertain what has been dope in many places by employing small steam-power auxiliary to sailing vessels; and as you have the means of doing so, I have taken the liberty of directing your attention to this important subject, which many of your correspondents could easily supply, and answer such queries as the following:—

The best system of applying auxiliary steam-power to vessels in the coasting trade, of 150 to 200 tons burden per register?

A description of any such?

Whether wood or iron preferable, and the cost?

The size of engine or horse-power, and whether applied to screw or paddles?

The draught of water, &c. &c., and any particulars as to the trade they may be engaged in, and how they are answering?

N.B.—Some time ago, a vessel was tried on the Thames (no notice of which has been taken in the *Engineer's Journal*),* called the Albion, with a new system of propellers, patented by a Mr. Simpson, which was very favourably spoken of as being adapted for the purposes referred to by me. —Could you state any particulars connected with it?

Trusting you may not consider my suggestions as out of place, and that any notice you give in your *Journal* of such improvements, will be very interesting, and give much information to many of you readers,

I remain, &c.,

A. B.

[* We were not present at the experiment, and not having much faith in newspaper reports, is the reason we have not noticed them.—Ed.]

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## NOTES OF THE MONTH.

An hydraulic telegraph is now being exhibited in the arcade at Exeter Change. It is on a very small scale, but works well.

On the Monmouth and Hereford line, a wooden bridge over the Wye is to be erected, at a height of 50 feet above high-water mark. The embankments are now in a forward state, and the frame-work is being prepared at Bristol.

Mr. John Fairfull Smith, secretary of the leading Glasgow railways, has addressed a letter to the Lord Provost, in reference to the late riots, and urges the necessity of aid, by a government loan being given to the railways. He says that 10,000 men, who are now supported by the public, might be employed on the railways in the neighbourhood of Glasgow, which are stopped by the state of the money market. The same views are spreading among the railway interest, and the mischief is felt of the repressive measures which were connived at by the established companies, thinking they should not feel the pressure. We always deprecated the government tampering, and the propriety of the cause we have advocated is fully justified by events. We do say the great question is, whether so many hundred thousand powerful and uneducated men should be left in a state of idleness, or whether they shall be employed on public works? They are already maintained by their own savings, by the contributions of their friends, by credit given by the small shop-keepers, or by theft, or in jail, or in the work-houses. The question is not one of finding mere food, but of giving work which shall do good to the common stock, and put the men in a happier condition. We hope the legislation will immediately be amended, the power of sueing for calls be withdrawn, and the power be given of allowing interest on calls, likewise a further power of raising money on debenture, or on loan notes. As the government have by their measures brought railway works to a stand, or dead lock, temporary and exceptional measures might be allowed, in order to set the machinery of investment again in action. We would even countenance the issue of railway notes, which should be a legal tender for all railway payments and calls, or the advance by government of exchequer bill loans; though on all ordinary occasions, we have always been opposed to their interference in any shape. The abolition of the Railway Board, founded on wrong principles of legislation, and calculated to preserve their memory, we consider an essential preliminary to a healthy course of action on the part of the government to the railways.

The electric telegraph is now taken up by the publicans. A dial is used in a smoking-room, marked with the various articles wanted, and corresponding with a similar dial in the bar.

A Royal Institution of Engineers has been founded at the Hague, which has two hundred members.

*On Annealing Glass Tubes.*—M. Bontemps read a paper at the Industrial Society of Mulhausen, on the causes of the breaking of glass tubes and cylinders. In order that a glass tube be in good condition, it is necessary that the interior particles should give way at the same time as the exterior. For this purpose, the tubes—such, for instance, as thermometer, barometer, and pressure-gauge tubes—are placed in a baking or annealing furnace, called the baking furnace, a brick casing of 6 inches diameter, and the length the tubes may require. This furnace is heated at one end to a dull red heat, at which the glass is nearly malleable, but not put out of shape; they are then (being in sheet-iron carriages, on wheels) drawn gradually to the cool end of the furnace, but so slowly, as only to traverse the distance in from 15 to 24 hours, according to the nature of the glass thus drawn gradually through a diminishing temperature to that of the atmosphere. There is a vast difference between glass baked and that unbaked—the latter is not so homogeneous, and polarises the light in passing through it. By applying, therefore, a fragment of a tube to a polarising apparatus, it can be ascertained if the tube has been baked.

*A Rare Shot.*—Commander Mackinnon in his "Steam Warfare on the Parana," mentions the following almost incredible instance of a shot passing through both of the paddle-wheels of his vessel, without touching any part of either:—"It struck the paddle-box on the enemy's side, 3 feet or 4 feet above the shaft, went clean through the wheel without touching any part of it, and then passed across the deck and through the other paddle-box, not above 18 inches from the shaft, still not touching a single blade, or any portion of the paddles. At the rate the wheels were revolving (about 17 times a minute), it appeared quite impossible to fire a pistol-ball through without striking some part of them; and yet this 18 lb. shot had gone through both wheels, leaving no mark but the hole at entering on one side and departing on the other.

*Curious Phenomena of Fire.*—At the Royal Institution, on the 17th of February last, a furnace was erected for the purpose of making some experiments on glass manufacture by Mr. Pellatt. In consequence of some accident, the lecture-room was nearly set on fire, but by timely aid the flames were extinguished. After a lecture at the Institution on the following Friday, Prof. Faraday called the attention of the members to two circumstances of philosophical interest which had happened during the momentary apprehension of fire.—1. At three different times the water poured on the cinders of the temporary furnace, when, on the fire being drawn, they fell on the hearth, became decomposed by the ignited carbon; and the hydrogen, driven by the sudden expansion of steam, &c., having penetrated the hot and porous hearth-stone, found its way to the heated beams and space which were immediately beneath.—2. This gas, though not in the state of flame as it passed through the hearth-stone and pugging, was after being mixed with the air below sufficiently hot to enter into combustion,—producing three gushes of flame downwards from beneath the hearth:—and it was experimentally shown that a temperature so low as barely to scorch paper, and in which the hand may be held for some seconds without inconvenience, is yet able to ignite a jet of coal or hydrogen gas in air.

*Liverpool Waterworks.*—The two Companies which supplied the town with water, and the Corporation of Liverpool who were empowered by Act of Parliament to purchase the existing interests for the purpose of taking the whole supply into their own hands, appointed Mr. Robert Stephenson as sole arbitrator to determine the amount of compensation to be paid to each Company. After a patient hearing of all parties, and a minute inquiry inte the works, he has made his award, by which the Harrington Water Company are to receive £330,719 and the Bootle Water Company £354,000. The former claimed £570,000 and the latter £354,000.

*Carlton Club Designs.*—A correspondent informs us that in a former number of the *Journal*, we were in error in attributing to Mr. Sidney Smirke the "*sole* designing" of the Carlton Club, now erecting in Pall Mall, as well as "the adaptation of Sansovino" in the exterior. He also states that the designs were *entirely completed* and *sent in* under the arrangement of the late Mr. Basevi and Mr. Sidney Smirke, during the lifetime of the former,—and that though Mr. S. Smirke may possibly make some deviations from their *joint* arrangement, yet the designs are, in the main, *to be executed* as agreed on between them.

*Prevention of Accidents in Coal Mines.*—The *Staffordshire Mercury* describes an invention by Mr. Edward N. Fourdrinier, of Cheddleton Mill, a very simple and ingenious, but important contrivance, for preventing the accidents which are constantly resulting from the breakage of the chain or ropes, and drawing the skip over the pulley, or the whirl, or run. The apparatus is now in daily use at one of Mr. Sneyd's pits, at the Sneyd-green Colliery, between Hanley and Burslem. In one instance the merit of the invention was fully tested by the chain being unintentionally drawn over the pulley; no disastrous consequences, however, resulted, the skip or rather cage being detached from the chain, and remaining safe on the guides. A heavy load was subsequently lowered about 40 yards down the pit, and the chain cut at about 20 yards above the surface, by which means no less than 60 yards of chain fell down the shaft. A man having been let down by a rope to ascertain the result, found the machine perfectly secured, and the chain safely coiled on the top of the cage in which the man ascends and descends. The man immediately attached the rope to the chain, which having been drawn up and repaired, was again let down and fastened to the apparatus. The whole was then safely drawn up, with the man in the skip, the experiment having occupied no more than 20 minutes, and no injury whatever having been sustained either by the machine or the guides. There can be but one opinion as to the great advantages to be derived from the general adoption of this invaluable invention, and it is to be sincerely hoped that no time will be lost in making this arrangement for the more effectual preservation of human life.

*On the Electro-Bronzing of Metals.*—MM. Brunel, Bessin, and Gaugin presented to the *Academie des Sciences*, at Paris, specimens of metals bronzed by electro-chemical means. M. de Ruolz, in 1841, communicated to the academy a process for bronzing metals, by depositing upon them, by the aid of the galvanic battery, layers, more or less thick, of brass or of bronze. This process, which required the employment of the double alkaline cyanides of copper and zinc, or of copper and tin, was not adopted in practice, on account of the great expense of the cyanides, and for other reasons. MM. Brunel, Bessin, and Gaugin, have substituted for the cyanides, a solution in water, of 500 parts of carbonate of potash; 23 chloride of copper; 40 sulphate of zinc; and 250 nitrate of ammonia. To produce bronze, a salt of tin is substituted for the sulphate of zinc. By means of these solutions of brass or of bronze, a coating can be given to cast or wrought-iron, steel, lead, zinc, tin, and alloys of these metals, with one another, or with bismuth and antimony, after a previous cleaning according to the nature of the metal. The operation is conducted with a cold solution. The metal to be coated is placed in connection with the negative pole of a Bunsen battery, a plate of brass or of bronze being employed at the positive pole. When the objects have been covered with a coating of the metal desired, and have received their proper colour, they will be found to rival the finest bronzes.

*The Ventilometer.*—An instrument the invention of a French naval officer, in command at La Rochelle, where it has been tried during four years, with singularly true results, and found to be a most valuable marine instrument, whereby the crews and ships stationed off the coasts may often be saved—the officers having several hours' notice, and knowing when to run out to sea or into harbour. The instrument itself, exteriorly, exactly resembles a mariner's compass; and, having been fixed due north, the needle will take up its position, and whatever point it designates, that wind will arrive in the 24 hours, but generally within the 12 to 18 hours; according to the time that the needle remains at such point, so long will the wind blow from that quarter; and according to the inclination of the needle from its horizontal and natural position, so will be the violence of the wind. The principle upon which the ventilometer has been constructed seems feasible. The magno-electric fluids surround our globe, and their direct action is visible in the workings of the mariner's compass. Winds being the result of electrical changes, are produced by a disturbance in these fluids, and continue until the exact equilibrium is obtained; neither do these winds burst forth immediately over our heads, but take their origin within a circle of immense circumference—taking our own position as the centre. Any undue action in any part of the fluids within this circumference, will have more or less influence upon the whole; but our ordinary senses cannot mark these changes, although we sometimes find nervous invalids remarkably sympathetic, and able to fortell what the healthy man cannot—yet, when the change does arrive, a few hours afterwards he is obliged to admit his own grosser senses. The delicate mechanism of the ventilometer forms itself into the centre of a certain undefined circumference, but the extent of whose influence does not exceed a space of 24 hours; any change taking place within this circle is notified—so that, suppose the vane to be pointing north, but that the ventilometer at the same moment points to south, then, within the 24 hours, the south wind will blow; but the ordinary change is from 12 to 18 hours, and should the ventilometer remain for hours, or days, at the same point, the same wind will continue blowing; but when it changes within the 24 hours, the wind will change also. This instrument is not influenced by the lighter breezes; when a strong wind blows, the needle, or indicator, is horizontal—but as the winds, or atmospheric changes, gradually increase in violence, the point is elevated by the weight of the atmosphere, and thus not merely preindicates the wind that is to blow, but its exact strength and duration. If the principle be proved to be correct, then, possibly, improvements may be made, by which even the highest breezes may be preindicated. It is about to be tried by the Admiralty.

*Sulphate of Iron for Purifying Gas.*—M. Martens, of the University of Louvain, has made a discovery in the use of sulphate of iron for the purification of coal gas. By this arrangement, the gas passes through two purifiers: in the first is placed 1 cwt. of sulphate of iron, dissolved in 83 gallons of water, and in the second milk of lime, made by adding 83 gallons of lime to 375 gallons of water. On passing from the second purifier, the gas is almost completely deprived of its sulphuretted hydrogen, that it scarcely changes the colour of paper moistened with a solution of oxalate of lead. By this process, there is a greater deposit of tar in the solution than when water alone is employed; and there is a much more abundant condensation of aqueous and ammoniacal vapours—so that during long-continued frosts, the pipes have been kept entirely free from ice, which causes considerable trouble and expense. The cause of tar depositing in a ferruginous solution more readily than in water, arises from the sulphate of iron having a greater affinity for the tar, which it condenses, and carries down with it; and the greater condensation of vapours contained in the gas is caused by a more complete absorption of ammonia, which always has a tendency to mix with other vapours. The above quantity of sulphate of iron is sufficient for purifying the gas from 25 to 27 tons of coal; the solution is then so impregnated to saturation, as to require changing. It is probable the residue of this plan may become a valuable article of commerce.

*White Paint Manufactured from Antimony.*—At the Liverpool Polytechnic Society, Mr. J. A. Forrest described a new mode of manufacturing white paint of an excellent body, superior to that manufactured from lead. It is made from oxide of antimony, and has many advantages. He had ascertained, that though it was now high in price, were there a demand for antimony, that metal could be obtained in abundance at about £12 a ton, whereas the lead used costs £24 10s. The new paint was, consequently, much cheaper; it was not so apt to lose its colour, and would spread over a much larger surface than an equal weight of the paint manufactured from lead.

*Sound made Visible.*—A method has been discovered and matured, by which sound will be made visible to the human eye, its various forms and waves demonstrated to sight, and the power to discriminate between the tones of one musical instrument and another be as complete as to observe the action of water when disturbed by any material cause. The experiments are likely to be ere long repeated in the Royal Society. The exhibition of effects on fine sand has probably led to this astonishing issue.

*Friction Hammer.*—A novel machine, just completed, is now at work at the Great Western Works, at Bristol, the invention of Mr. John Jones, manager of the works, who also invented the "Cambrian Engine." The machine is called a "Friction Hammer," and consists of frames of cast-iron, in which are vertical slides acting as guides to the hammer, and also supporting the machinery necessary for putting the hammer in motion. The hammer consists of a plane bar of flat wrought-iron, so arranged as to work in the slides, and is raised by means of two vertical rollers turning in opposite directions, which are made to bear upon the bar by an exceedingly simple arrangement of levers. A slight pressure upon the handle of one lever raises the hammer to any height not exceeding 7 feet; the pressure being removed it falls by its own gravity; this lever is also arranged so as to stop the hammer in any part of its descent, should circumstances render it necessary. The friction rollers are put in motion by means of straps and pulleys, fly-wheels being also fitted on each strap.

*New Method of Treating the Ore of Platinum.*—Instead of the tedious operation of obtaining pure platinum from the ore, employing 8 or 10 parts of acid to one of platinum, M. Hess suggests the following as an improvement:—Melt one part of platinum ore with two or three of zinc, which will form an alloy very friable, and easily reduced to a fine powder. This powder is then to be sifted, and on it poured dilute sulphuric acid at the common temperature of the atmosphere. The temperature is then gradually raised, and the metals allowed to macerate as long as there is anything to dissolve; the acid in a short time separates all the zinc from the alloy, and the principal part of the iron contained in the ore. A solution is obtained in which hydrosulphuric acid produces no precipitate. Having poured off the liquid, the residue is a fine powder, which, having been well washed, is treated with nitric acid, which dissolves the copper, and other foreign metals; the platinum is then dissolved in nitrochloric acid, and then proceeded with in the usual way.

*Gas Motive Power.*—At the *Academie des Sciences* a report was read on a "gas-propeller," invented by the late M. Selligue, in 1844. It consists of an iron cylinder in the form of a **U**—one end is closed; water is poured in to a certain height, and in the open end is placed a piston and rod, in the usual manner. On introducing any explosive gases over the water, in the closed end of the tube, and effecting their combustion, the resulting gases press, by their sudden expansion, the liquid on which they rest, and force up the piston to a certain height, which is again depressed by the cooling and condensation of the gas, and the atmospheric pressure on the piston. A regular reciprocating motion is thus obtained, which, of course, can be applied to every description of machinery. In closely experimenting on this principle of motive power, it has been found, that eight volumes of air, and one of gas, obtained from the decomposition of water, by passing steam through cylinders filled with red-hot charcoal, consist of hydrogen, 66; carbonic oxide, 28; carbonic acid, 8. The gas can be manufactured for one-fifth of a halfpenny per 140 quarts, which is considered equal to 8 cubic inches of steam at one atmosphere pressure, and costing one halfpenny and three-fifths. The inventor found, that 35 quarts of gas, and 280 quarts of air, gave an explosive force equal to 125 tons, and 2,400 explosions can be made per hour.

## LIST OF NEW PATENTS.

GRANTED IN ENGLAND FROM FEBRUARY 28, TO MARCH 22, 1848.

*Six Months allowed for Enrolment, unless otherwise expressed.*

Elizabeth Wallace, of Laurel-lodge, Cheltenham, Gloucester, spinster, for "certain Improvements in facing, figuring, designating, decorating, planning, and otherwise fitting up houses and buildings, parts of which are applicable to articles of furniture."—Sealed February 28.

John Craft Roberts, of Holywell, Flintshire, surgeon, for "a simplified and improved mode of communicating intelligence, by means of electricity and magnetism, combined, or not, with steam on railways, between the carriages on the line and the engine or tender, so that the guards and passengers may give notice to the engineer or engine-driver, for the prevention of accidents or casualties, or the mitigation of the evil thereof, and the protection of human life and property from loss or injury; and, also, of communicating signals by the same agency, describing the cause or causes of alarm, and a new mode of securing the passage of electricity, for the above purposes, to be substituted or not for the side chains, and of communicating intelligence between distant places on the line."—February 28.

William Palmer, of Sutton-street, Clerkenwell, for "Improvements in melting fat and in the manufacture of candles."—February 28.

Charles Ritchie, of Aberdeen, Scotland, engineer, for "certain Improvements in locomotive and other engines."—March 2.

Francis Whishaw, of Hampstead, Middlesex, civil engineer, for "a certain manufacture of pipes of earthenware, pottery, and glass, and of certain applications and arrangements thereof."—March 8.

William Exall, of Reading, Berkshire, engineer, for "certain Improvements in thrashing machines, and in steam-boilers, engines, and other apparatus for driving the same, which apparatus is applicable to driving other machinery, part of which improvements is a communication, and the remainder is his own invention."—March 8.

James Lockhead, of Milton, Gravesend, Kent, for "certain Improvements in ventilation."—March 8.

Theodorus Cornelius Seeger, Knight of the Order of Reiderlandsche Lion, of Saint Gravenhage, Holland, but now of Leicester-square, Middlesex, physician, for "Improvements in the construction of railway carriages."—March 8.

William Beckett Johnson, of Liverpool, engineer, for "certain Improvements which are applicable to locomotive, stationary, and marine steam-engines."—March 8.

Warren de la Rue, of Bunhill-row, Middlesex, manufacturer, for "Improvements in machinery used in the manufacture of cardboard and pasteboard." (A communication).—March 8.

John Houston, of Stepney, Middlesex, surgeon, for "Improvements in obtaining motive power by the aid of atmospheric air, and in obtaining combustion."—March 8.

George Royce, of Fletland, Lincolnshire, for "Improvements in machinery or apparatus for depositing, cleansing, and grinding corn and seed."—March 8.

George Lloyd, of Stepney, Middlesex, iron-founder, for "certain Improvements in furnaces and blowing machines, and improvements in engines and machinery for driving the same, which improvements are also applicable to other purposes where motive power is required."—March 8.

Joseph Maudslay, of the firm of Maudslay, Sons, and Field, of Lambeth, engineers, for "certain Improvements in obtaining and applying motive power, and in the machinery and engines employed therein."—March 8.

John M'Conochie, of Liverpool, engineer, and Louis James Claude, of Bootle, Lancashire, engineer, for "certain Improvements in locomotive engines."—March 8.

Alexander Alliott, of Lenton works, in the county of Nottingham, bleacher, for "Improvements in apparatus used in the working of steam-boilers, also in apparatus used in cleansing flues."—March 8.

John Henderson Porter, of Blackheath, Kent, engineer, for "Improvements in iron girders, beams, trusses, and supports, and in rendering the floors of buildings fire-proof by the use of iron."—March 8.

Henry Bashard Hobdell, of the city of Oxford, goldsmith, for "Improvements in studs and buttons."—March 9.

George Coode, of Haydock-park, Lancashire, for "an Improved method or methods of distributing over land liquids and substances in a liquid or fluent state, and certain improved apparatus and machinery employed therein."—March 11.

John Ashbury, of Openshaw, near Manchester, for "certain Improvements in the construction and manufacture of wheels for use upon railways and common roads, and in the methods of preparing and constructing the tyres used thereon."—March 11.

Alexander Alliott, of Lenton Works, Nottingham, bleacher, for "Improvements in spring apparatus and in balances, also in breaks, and in the means of working breaks."—March 14.

James Porritt, of Edenfield, Lancashire, for "certain Improvements in carding-engines for carding wool and other fibrous substances."—March 14.

Frederick William Michael Collins, and Alfred Reynolds, both of Charterhouse-square, Middlesex, engravers and printers, for "Improvements in the art of ornamenting china, earthenware, and glass."—March 14.

John Hosmer, of New Cross, Surrey, surveyor, for "Improvements in apparatus for supplying water and for cleansing drains and sewers."—March 16.

George Ellins, of Droitwich, Worcestshire, salt manufacturer, for certain "Improvements in manufacturing salt, and in apparatus for manufacturing salt."—March 22.

William Edward Newton, of Chancery-lane, Middlesex, for "an Improvement or improvements in making coupling joints for pipes, nozzles, stop-cocks, still and cylinder heads, and other apparatus." (A communication.)—March 22.

Henry Bessemer, of Saint Pancras-road, Middlesex, for "Improvements in the manufacture of glass."—March 22.

William Henderson, of Park-head, Lanarkshire, Scotland, chemist, for "Improvements in treating lead and other ores."—March 22.

Joseph Orsi, of Guildhall-chambers, gentleman, for "certain Improvements in the manufacture of artificial stone, cements, ornamental tiles, bricks, and quarries." (A communication.)—March 22.

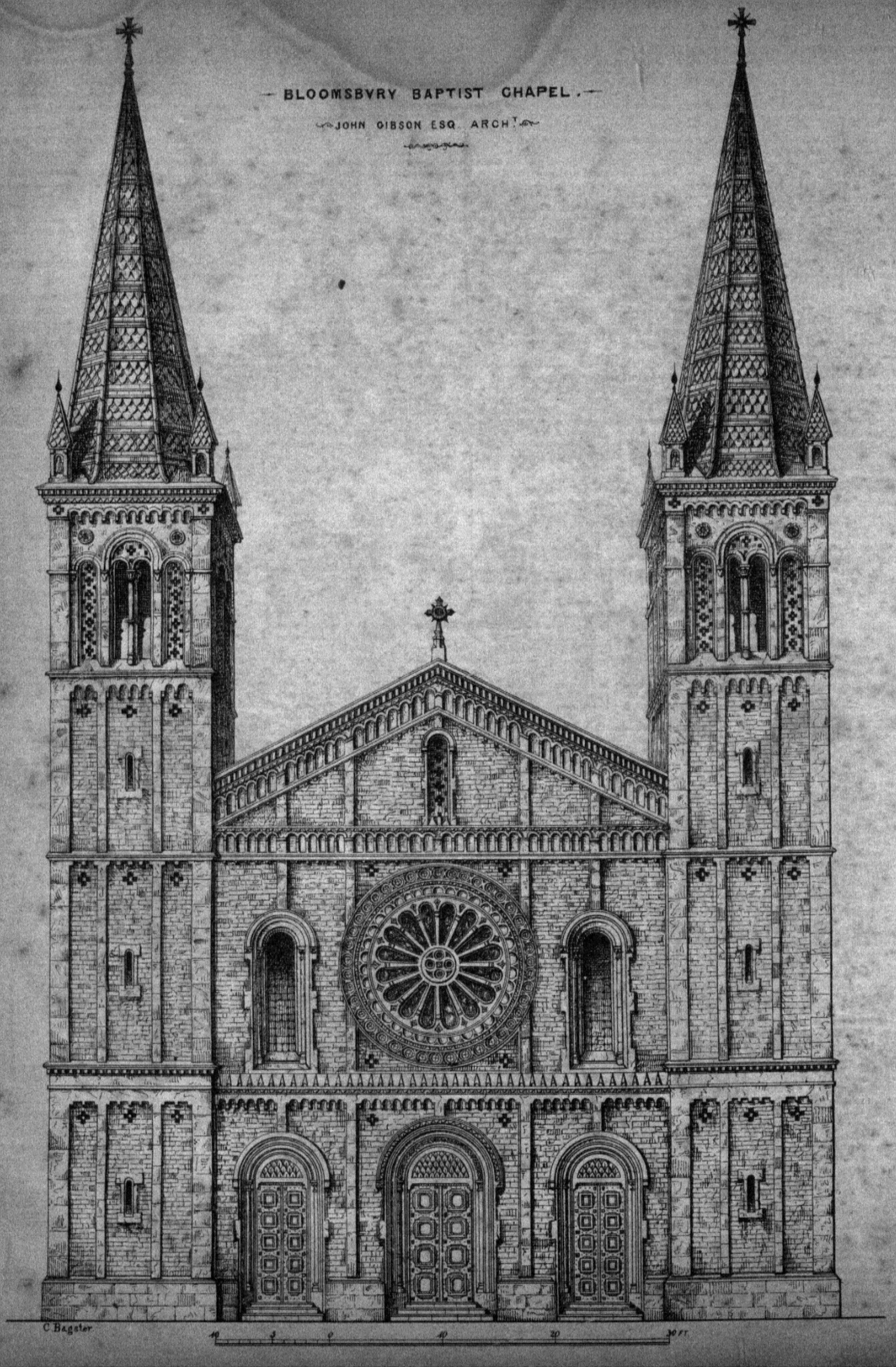
William James Dailey, of Lambeth, Surrey, lithographer, for "certain Improvements in machinery for propelling."—March 22.

John Lawes Cole, of Lucas-street, Middlesex, for "certain Improvements in steam-engines."—March 22.

PLATE VII

# BLOOMSBVRY BAPTIST CHAPEL.

JOHN GIBSON ESQ. ARCHT.



## BLOOMSBURY BAPTIST CHAPEL.

John Gibson, Esq., Architect.

*(With an Engraving, Plate VII.)*

Bloomsbury-street now presents a very unusual, if not altogether unprecedented, assemblage of church architecture, there being there no fewer than three churches—at least, places of public worship—together in a line by the side of each other. With general similarity of purpose, they display great variety, or we might say contrast. That to the north—namely, Bedford Chapel, or what used to be so called, and which was originally of a most dismal "tabernacle" appearance—was merely re-dressed externally a year or two ago; a circumstance that perhaps excuses many defects and inequalities in the design, the architect being compelled to retain all the former openings, both doors and windows, —and it would seem, the former turret and a bit of the gable also, which are seen sticking up most awkwardly over the now horizontal line of the front. Were it not for that, and for the meanness of the doors, the front would have been passable.

The second of the three buildings in point of date is the south one,—a French Protestant church, with a small residence for the clergyman attached to it. For this, the style adopted is Gothic; but the design is exceedingly sober and unpretending, there being scarcely anything in it except the large window to give it expression. Even that feature is not made so much of as it might have been; for although sufficiently correct as to mere form and composition, it has a tame and spiritless look.

The Baptist Chapel, which comes in immediately between the two other buildings, is by far the most ambitious and conspicuous of the three. It is that which announces itself most distinctly as a church—in fact, much more as a "church" than as a dissenting place of worship, the latter having hitherto generally eschewed instead of at all affecting, the ecclesiastical orthodoxy of towers, and spires; while here we have not only tower and spire, but a pair of them. And here they produce a most agreeable diversity of outline, not only as regards the structure to which they belong, but the general group of all the three; more especially as the aspect of their fronts is an east one,—wherefore they are invariably in shadow, except early in the morning. Standing out in bold relief against the sky, and catching the light on one of their other sides, the towers serve to produce some play of light and shade, as well as form and outline. They tell very strikingly in the view from New Oxford-street,—perhaps more so just now than they will do some time hence, for at present they occasion something like surprise also, they seeming to have started into existence all at once, as the building was begun only last autumn. Owing to a singularly happy accident—to mere accident, and nothing more—one of the towers displays itself very picturesquely from Hart-street—near by St. George's, Bloomsbury,—at the end of a vista, formed by a cross-street that runs obliquely from New Oxford-street, into Bloomsbury-street.

The style of this Baptist Chapel is of exotic character to English eyes, it being mediæval Italian or Lombardic; but whether selected on account of its being unlike our own Anglo-ecclesiastical style of the same period, we cannot say; but, we must observe, the addition of campanili partakes very much more of English Gothic than of Lombardic physiognomy and mode of composition. As our engraving explains the design itself much more intelligibly than the most accurate description could possibly do, we need not even attempt any; accordingly, we shall confine ourselves to a few remarks. While we readily confess that the architect (Mr. John Gibson, whose name was quite unknown to us before) has shown competent knowledge of the style generally, we also desiderate more regard to the spirit of it in some of the details. The uppermost story of the towers, and the large circular window, are satisfactory enough; not so, however, the doorways, which might very properly have been made far more important features,—important, we mean, not as regards size, but with regard to design and execution. Such parts of a building being those which are most clearly of all seen,—in fact, those which subject themselves to the closest inspection, they naturally demand more elaborate ornamentation and finish than others which can be seen from, comparatively, only a distance. Such at least seems to have been the principle generally observed by mediæval architects, whose doorways and portals were frequently most profusely adorned, even when all the rest of a façade was either featureless or left quite plain. The bestowing particular attention upon them is indispensably requisite for any adequate characterization of the Lombardic style; more especially as, unlike the Gothic, it affords very few resources of design for windows (circular ones alone excepted), which were seldom more than mere small single openings, without any of that variety and richness which arise from mullions and intersecting tracery. If not richer in their general design, the doorways of this chapel might very well have been considerably bolder in their details and execution. Were they more deeply recessed, and their mouldings in greater relief, they would make a far better appearance.

The building is of white brick, with ornamental dressings of Caen stone. The spires are constructed of timber, and are covered with ornamental tiles. The width of frontage is 70 feet, and the height to the top of the spires 115 feet.

The interior affords accommodation on the ground floor for about 460 persons in pews, with a vestibule and two vestry rooms. In the towers are staircases leading to the basement and gallery floors, the whole extent of the former being set apart for two schools, for boys and for girls. The galleries occupy three sides of the chapel, with an organ gallery on the fourth—these will accommodate 470 persons in pews, with a separate gallery for 250 children; total accommodation, 1,180.

The span of the roof, clear of supports, is 65 feet. The height from the floor to the ceiling is 39 feet. The whole building is nearly a square, and covers a superficial area of 5,150 feet.

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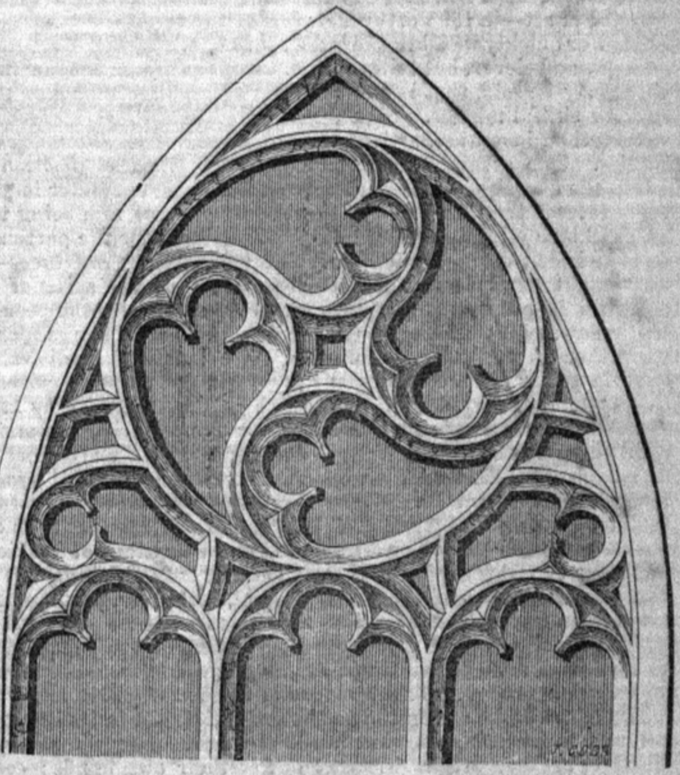
* When alteration was going on, it would surely have been worth while to remove the entrances to the "wine vaults" beneath the chapel, from the front to the side;—or better still, if it could have been done, to the rear of the building, where they would have been entirely out of sight.

## GOTHIC WINDOW.



Sir—During the autumn of 1846, in which I stayed some weeks at Boppart, on the Rhine, I met with, in an old church at that place, a Gothic window, of which I made memoranda. From these, a friend has been enabled to send me the inclosed. I now forward it to you, in case you may think it worthy of insertion in your very useful publication.

I am, yours, &c.,

I. J. Chapman.

*Athenæum Club, Pall Mall,*
*March* 16, 1848.

# CANDIDUS'S NOTE-BOOK,
## FASCICULUS LXXXI.

> "I must have liberty
> Withal, as large a charter as the winds,
> To blow on whom I please."

I. We are never, it would seem, to have more than one view of the new Palace of Westminster; for though many representations of it—or what call themselves such—have been published in various shapes, they are merely copies either of the first one, or of each other; all of them showing only the river front, as taken from the south-east. What sort of fidelity and taste stamps such barefacedly piratical manufacture, may be more readily imagined than decently—at least temperately expressed. Nothing less than nerves of iron—or else a thorough callosity of mind that is hardly conceivable in such an artist, can enable Mr. Barry to endure some of the abominable libels so inflicted upon him. Schinkel, Kleuze, Gärtner, and other foreign architects, have been similarly libelled, and perhaps more grievously still; but then there are their own authentic representations of them, as well as their buildings themselves, to show to those who have no other means of judging of them, what the latter really are; whereas, without such incontrovertible evidence to the contrary, some of them might be supposed to be the most barbarous and miserable things ever erected,—at least, such would be the case were it not that the very vileness of the representation comforts us with the assurance that the structures themselves cannot, by any possibility, be so hideous.

II. That plodding adherence to precedent, which is now made a *sine-qua-non* in design by those whose influence and authority—more especially in matters of church-building—amount to dictation to architects, has a tendency to operate injuriously to art, in various ways. For art—in the worthy meaning of the term—is substituted what is or quickly will become mere routine, sufficiently dexterous, perhaps, and clever, but still routine. As far as design is concerned, all, it may be said, that is now required of architects is, that they shall be skilful mimics. Such talent will stand them in stead of imagination, invention, artistic feeling, contrivance, and much else besides. The architect is in fact degraded from his position as artist, the exercise of the faculties which such character implies being interdicted him, and all that is expected of him being that he shall scrupulously adhere to express patterns for the particular style he is called upon to imitate. Daily experience convinces—at least might convince us that, somehow or other, the spirit of the originals is not transfused into the copies, or else the peculiar sentiment and associations connected with the former evaporate altogether in the latter. Moreover, the example of mediævalism itself is, so far from affording any *precedent* for, rather opposed to that system of torpid imitation which is now regarded by many as the most salutary and efficacious for art. During the middle ages, there was continual change and innovation in architecture, by means of which transition was made from one marked general mode or style to another. So far was precedent from being regarded, that not even uniformity of design and style was attended to in edifices which were carried on by successive generations of builders; and some of which exhibit in themselves, not only different, but the two extreme phases of the Pointed style, including, perhaps, portions in an anterior style, The architects of those days did not suffer themselves to be trammelled by precedent—to be tied down to repetition and copying, even where they would have contributed to unity of *ensemble*. Then, instead of that *stand-still* in art, which we seem to consider essential to the maintaining it in its integrity, all was innovation, progress, productiveness. The art was productive, because artists wrought out of their own minds; consequently, infused mind, intelligence, spirit, and spontaneity into their productions. They did not then reject new ideas merely because they were new, nor the suggestions of imagination out of the timid apprehension of being censured as incorrect, if not absolutely heretical in taste. They did not, as we now do, abide by ready-made, and ready cut-and-dried patterns, but designed all their details freely, for they employed what was to them their vernacular language—their own mother tongue in art, whose character and idioms they helped to frame, and in which they expressed themselves instinctively. To us at the present day, the style they used has become a dead language; one in which, by dint of study, we may attain to considerable proficiency; but which we do not think in, and which does not supply words and expressions for modern things and modern ideas. We may indeed so call it, but mediæval English architecture is no longer our National style, if by "National" we are to understand the prevalent style of building generally employed by us for all purposes and occasions alike. We may be mediæval in our churches, just as we may be Ciceronian in Latin orations at colleges and schools. But we ourselves are all the while getting further and further off from mediævalism every day. Free Constitutions, Republics, and Chartism, do not indicate any great attachment to the spirit of mediævalism.

III. We are now, it seems, likely to have, for the very first time, a work that shall fairly answer to the character of a Dictionary of Architecture, which those which have hitherto appeared under such title have been very far indeed from doing. They have, almost without an exception, been little better than mere trading speculations,—things manufactured for the market; and some of them have been such arrant scissors-and-paste work, that hardly any market could be found for them. The epithet, "Architectural," applied to Nicholson's, is little less than an arrant misnomer; therefore, I am not at all surprised at the present proprietor of the copyright having been told, as I happen to know, by one whom he was solicitous to engage to bring out a new edition of it, that in order to be rendered at all what it would now require to be, it must be entirely re-written from beginning to end, and amplified to almost double the quantity of letter-press. As the Dictionary now promised us is to be the undertaking of a society, there is reason for expecting that it will be uniformly well-executed throughout. Very great room for improvement upon everything there is at present of the kind either in our own or any other language there certainly is, if only because materials have so greatly accumulated, and so many matters and subjects have come up that ought to be not merely noticed, but treated of pretty fully. At the present day it would, for instance, be unpardonable to omit such terms, and the information connected with them, as Cinque-cento, Renaissance, Rococo, and numerous others either of a similar or different class.

IV. If the Dictionary *in petto*, here alluded to, is to contain articles of architectural criticism and æsthetics, it will have to supply a very great deal indeed merely in that single department of it. In fact, the artistic philosopy of architecture has scarcely been merely touched upon at the best, and that very vaguely, loosely, and drily,—whereas it requires to be fully elucidated by actual instances and examples. Character, Composition, Contrast, Effect, Grandiose, Grotesque, Heaviness, Picturesque, Purity, Richness, Simplicity, and many other terms, might be made to furnish exceedingly interesting and instructive articles—such as would assist very much in popularising the study of architecture. That it greatly needs to be popularised can hardly be disputed. Of very little use is it for its professional followers to call architecture the queen of the fine arts—or rather their so calling it partakes of the ridiculous, while the public are for the most part utterly indifferent to it as a fine art; and that such is the case the exhibitions at the Royal Academy strongly testify, where the picture of a "posy-faced" girl, or of a damsel painted "in buff," will attract crowds of spectators, while the architectural room is a desert, or used only as a thoroughfare. The pictures, in fact, possess so much stronger attraction for the many, that the architectural drawings are comparatively quite disregarded, or if looked at, are looked at rather as pictures than as designs, and judged of not so much according to the architectural merits and ideas which they display, than according to ability of execution, and the pictorial qualities put into them; which last species of artistic recommendation is quite distinct from architectural value, and is what may be imparted by a skilful pencil to very poor, or even wretchedly bad designs.

V. If the notices bestowed upon the Fine Arts by the newspaper press may be taken as a fair criterion by which to judge of the favour in which they are respectively held by the public, Architecture san be scarcely above zero according to such thermometer of popularity. Although the class of publications just mentioned professes to be *au fait* on every subject, architecture is ignored by it; and why?—because it can be done with impunity. Is it to be supposed that such a journal as the *Times* could not, if it thought it worth while to do so, command as able assistance in the department of the Fine Arts generally, and architecture among them, as in any other? Most undoubtedly it could; and would do so, were there, on the part of the public, any demand for such information and instruction. We may therefore fairly conclude that there is none. This seems discouraging enough, but is said not for the purpose of discouraging, but, on the contrary, of stimulating architects, and inducing them to make an effort to create greater general interest in behalf of their art. Their vaunting it to each other is useless, and little better than so much idle vapouring. It is the public, not they themselves, who require to be convinced of its importance and excellence. Yet, what has the

"Institute" done towards promoting and disseminating architectural taste among the public? The answer must be—just nothing at all. The mere idea of anything of the kind does not appear to have even so much as occurred to them. Nay, the "Institute" might be extinguished to-morrow, and neither the art, nor the profession, nor the public would miss it. Although I do not pretend to be a particular admirer of the "Institute," I am, in one sense, its warmest well-wisher, since most earnestly do I wish that it would signalize itself, by doing, or attempting to do, some real service to architecture, as a branch of Fine Art. At present, that body is not only exceedingly drowsy itself, but its torpidity has a benumbing effect which extends beyond its own immediate sphere. Still, I am not for having the "Institute" abolished; but I do wish that it were entirely re-constructed. If I cut it up, it is only for the purpose of its being thrown into Medea's cauldron, to be resuscitated in a better form, and come forth again vigorous and energetic. Or if a fresh and more genial spirit—if greater activity, and greater sympathy with Fine Art, can be infused into it, without resorting to the process of re-construction, the sooner it be done the better. Were I less devoted than I am to architecture, the "Institute" would not be thus reproached by me; and if to be so enthusiastically devoted to that art, as to be quite regardless whom I please or offend while advocating its interests, should subject me to reproach in return, I can endure it with far more of pride than of shame.

VI. The natural death of Ludwig the First of Bavaria would have been many degrees less distressing than is his moral and political one, by which he has terminated his career that forms an epoch in the history of art, as an infatuated old dotard. Scarcely ever before has so much been done by an individual prince for the embellishment of his capital, as has been accomplished by Ludwig for Munich; whose name has in consequence become a familiar household word in the mouths of artists throughout all Europe. What other princes have done for art has been in a great measure out of either ostentation or policy; but the ex-king of Bavaria seems to have been all along warmly attached to art for its own sake. It was himself personally that originated the idea of, and sedulously watched through their progress, monumental structures, some of which would of themselves highly sufficed for recording architecturally an entire reign. No very excessive hyperbole is it to say, that the reign of Ludwig has been equivalent to the lengthened rule of a dynasty, when we compare Munich with what it was some thirty years ago and now *is*. And *now*!—why now, the tears shed over his coffin would have been far less painful than the sigh which we give to his folly and his fate.

VII. There is a vast deal of prate and palaver about Proportions, as if all beauty in architecture were referable to them alone, independently of all other qualities that go to make up beauty, and independently of all circumstances. It is so convenient to have what looks like irrefragible and authoritative doctrine, and a theory so compact that it may be put into anutshell, or carried on the tip of one's tongue, ready to dart out the magic word —Proportions. Yet, so far from being on that account a simple one, such theory is an exceedingly complicated and abstruse one. If we ask what are beautiful Proportions, we shall be told "just" ones; when, if not satisfied with such elucidation, we return to the charge and inquire what are just Proportions, we shall, perhaps, be further enlightened by being assured that they are those which are harmonious and conduce to beauty. For the human figure and other animal forms, there are standards of normal Proportions, fixed by nature herself. But in architecture, there is no immutable standard of Proportion for any one style, much less one applicable to all styles alike. In the Greek orders, we find the very extremes of proportion—such as could not be exceeded either way without falling into deformity and disproportion—in the Pæstum Doric, and the slender, comparatively too slender, Corinthian. Yet, utterly dissimilar as they are, all the orders may be said to be admirably proportioned in themselves; which, however, instead of at all simplifying the matter, only renders the subject of Proportion the more abstruse and perplexing. The very best Proportions are only relatively good, for differently applied they might be far from pleasing, or even be absurd;—at the utmost, only average proportions, suitable for general guidance and for ordinary cases; and so far from being abided by, such average may frequently be greatly exceeded with the happiest effect. What, for instance, is loftiness but an unusual degree of height in comparison with breadth, or height exceeding the usual relative proportion which it bears to width? To attempt to fix invariable Proportions by rule is worse than nugatory, since it is positively mischievous, and detracts from the privileges of art; rendering that a merely mechanical process which ought to be determined very differently. After all, it is the eye which judges of Proportions; therefore, surely the eye of the architect—supposing him to be at all worthy of such name —ought to be able to decide what are pleasing Proportions quite as well as that of other people. And so that they be pleasing, it matters not at all how much they deviate from ordinary routine and its rules. Undue stress is laid upon Proportion, because it is generally spoken of as if it were all-sufficient in itself alone, and capable of ensuring excellence; whereas, it is only one element of beauty in design. Besides which, the term itself is usually understood in only a very limited meaning—namely, with reference to that mechanical species of it which concerns itself with merely parts and individual members or features, without that higher artistic one being included in the idea of it, which regulating the whole of a composition, stamps it to the eye at once as a captivating *ensemble*, all whose parts are in perfect keeping. That kind of Proportion is quite beyond the reach of rules. Those who cannot find out for themselves how to produce it, must dispense with it, trusting that it will never be missed by those who are content with Proportion in pieces and bits,—by hairbreadth measurers of columns and mouldings.

VIII. Odious as the Window-tax may be as a tax, I cannot at all agree with those who consider it, or talk as if they did consider it, to operate injuriously upon architectural design. So far is appearance from being at all benefitted by a multiplicity or frequency of windows, that the fewer the windows the more satisfactory is external appearance; for unless sparingly introduced, such openings sadly interfere with breadth and repose. We certainly do not find that in designs produced as specimens of their author's taste, consequently composed without the slightest regard to the Window-tax, they are at all prodigal of windows. If the Window-tax be felt a peculiarly onerous and oppressive one, let it by all means be got rid of; but in the name of common-sense, don't let its effect upon architectural design be urged as a reason for its removal, because if taste is to have any voice in the matter, it might find a very strong plea for the obnoxious tax being doubled, or even trebled. With regard to the purpose for which windows are necessary at all, rooms may have too much light, or too much window-surface, as well as too little. The cheerfulness of a room does not depend so much upon the quantity of light admitted into it, as upon many other circumstances; and foremost among them is the air of comfort, or of both combined, which it exhibits itself. Much also depends upon situation; for the latter may be such as to render the minimum of exposure to our view of it desirable. Again, the sort of cheerfulness derived from window-light is entirely dependent upon the weather: if that be gloomy and cheerless,—*triste* and dull. In dismal weather—no very great rarity, by the by, in this climate,—a blazing fire is far more exhilarating than the mere daylight. Of *quantum* of window or aperture for light in a room, there may be excess just as well as deficiency. Yet, because light is indispensable, it is thought that there cannot possibly be too much of it.

IX. While some of the studies and qualifications enumerated as requisite for the architect are very remotely connected with either the practice or theory of his art, even if they can be said to be connected with it all, others there are which are overlooked—at least passed over in silence. It is difficult to repress a smile when we find History and Biography included among the studies which an architect ought to be conversant with—for why not Geography also—more especially *Poliography*, or descriptions of cities and theirpublic monuments. The *quantum* of History, however, is so far from being formidable, that it dwindles down into a mere homæopathic dose,—no more of it being insisted upon than what relates to architecture. Just the same is it with Biography; for architectural biography is exceedingly scanty indeed, and does not at all tend to encumber biographical dictionaries. Mr. Donaldson points only to one source for it—to Milizia alone, without so much as mentioning Temanza, Quatremère de Quincy, and Cean-Bermudez. Of biography in general, it may safely be predicated that it is "a most attractive branch of history;" but the same cannot possibly be averred of architectural biography as a particular species of it, because, as it has hitherto been treated, it is particularly dry; a fault that might be forgiven, were it not also particularly *jejune*. Biography, says Mr. Donaldson, when speaking of its importance to the architect, "teaches us the course by which great men have attained to eminence;" yet that cannot be said of the species of it which he must be supposed to have had exclusively in view. On the contrary, it leaves us wholly ignorant of the studies and mental impulses to which the "eminent" in the profession have been indebted for their ability, and their distinction in the art. Nay, we very rarely learn what were the external matter-of-fact circumstances that shaped out and attended their professional career. Biographical notices of architects we most undeniably have, yet scarcely anything really deserving the name of architectural biography,—nothing written *in extenso* and fully developed. Passing over other studies which are strangely claimed for the architect, I will point out what, although overlooked, I myself conceive to be very essential qualifications—I say essential, not indispensable,—because daily experience convinces us that dispensed with they are. Now I should say that talent for Invention and Contrivance stands almost foremost among the qualifications for an architect. Without it, he can be little more than a barren copier,—the creature of *comme-il-faut* routine; a very respectable automaton, but not an artist. If we care only for mechanical skill and excellence, let us boldly say so at once, and desist from that maudlin, namby-pamby prating about architecture as art,—except it be just that brevet grade of the latter, by virtue of which tailoring and cookery claim to be enrolled among the so-called arts. For the display of other talent and merits, the opportunities are comparatively few; but those for the exercise of Contrivance are continually presenting themselves. It is what so far from requiring favourable circumstances, is most of all called into operation by disadvantageous ones, and by difficulties and untoward circumstances which, by a little exercise of it, might be overcome, not only sufficiently well, but even happily, and so as to be productive of both conveniences and beauties that would not have been thought of but for the obstacles which prevent compliance with usual matter-of-course proceeding. A taste for and acquaintance with art generally, as well as his own particular branch of it, is also highly desirable, if not indispensable, for the architect—a taste not so much, perhaps, expressly for painting and sculpture themselves, as for pictorial and sculpturesque decoration; and as regards an eye for colour, effect, and various combinations of form.

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## ON THE STABILITY OF ARCHES.

*On the Stability of Arches, with practical methods for determining, according to the Pressures to which they will be subjected, the best form of Section, or variable depth of Voussoir, for any given Intrados or Extrados.* By GEORGE SNELL, Assoc. Inst. C.E.—(From a paper read at the Institution of Civil Engineers.)

The first section of this paper treats of the general conditions of stability in structures composed of many blocks of materials, as walls, arches, &c. The second and third sections discuss the conditions of stability of an arch, the form of which and the pressures sustained by it, as regards position, direction, and amount, are similar on either side of the crown of the arch; such as an arch sustaining its own weight only, or that of a symmetrical superstructure. In the second section the arch is supposed to be formed of blocks of an incompressible material; but in the third section the limited strength of materials is taken into consideration. The fourth section discusses the conditions of stability of an arch, acted upon by forces of any amount, applied in any position and direction in the plane of the section, or of an arch whose form is not similar on both sides of the crown.

The effect of the adhesion of the cement is not taken in any case into consideration.

### SECTION I.

ART. 1.—A structure built of blocks of stone or other material, as A B C D, diagram 1, may yield under the pressure to which it is subjected; first, by the slipping of certain of its surfaces of contact one upon another, as diagram 2;—secondly, by the blocks turning over one upon the edge of another, as diagram 3;—or thirdly, by the yielding of the materials of which the structure is composed, as diagram 4. For the first effect to take place, it is necessary that the resultant $P_2$, of the pressure $P_1$, on one of the blocks A, and weight of A, should act in a direction inclined to a perpendicular drawn from the surfaces of contact, at an angle greater than L A R, the "limiting angle of resistance" of those surfaces. For example, if the materials are calcareous oolite, this angle, L A R, is 36° 30′; and if, as in diagram 2, the direction of the resultant is more inclined from the perpendicular than this angle, failure will take place, from the one block slipping on the other.

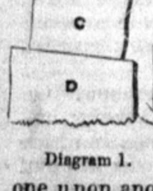

Diagram 1.

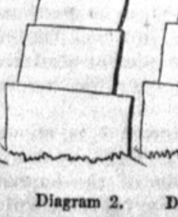

Diagram 2.

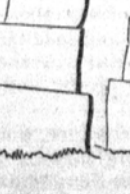

Diagram 3.

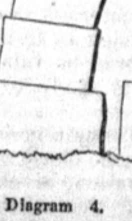

Diagram 4.

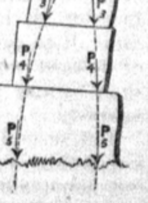

Diagram 5.

For the second effect to take place, the resultant pressure must act in a direction which passes without the joint, as in diagram 3.

The third effect depends, first, on the strength of the material; secondly, on the amount of the resultant pressure; and thirdly, on the position and direction of that pressure. Thus the material may be capable of sustaining the pressure, if it acts through the axis of the stone; the pressure in that case being equally distributed over the whole surface of contact; but if the direction of the pressure approaches very closely to one of the edges, so that one portion of the block sustains a much greater pressure per square inch than another, then the material may yield and failure ensue, as in diagram 4.

If, however, none of the resultant pressures $P_2$ $P_3$ $P_4$ $P_5$, diagram 5, fulfil any of the above conditions, that is, if none are inclined from a perpendicular to the surface of contact at an angle greater than the limiting angle of resistance of those surfaces, nor fall without the joint, nor approach so near to the edge as to cause the material to yield, then the structure will withstand the pressure $P_1$. Also, if instead of the pressure $P_1$, the structure be acted on by a pressure $p_1$, and the resultants $p_2$ $p_3$ $p_4$ $p_5$, do none of them fulfil any of the conditions of failure, it will withstand this pressure. In like manner, an endless variety of pressures, or systems of pressures, may be sustained by the structure, each giving a different series of resultants on the successive joints.

ART. 2.—If any other joints are made in the structure, the position and direction of the resultant pressures on them, also, must be drawn and examined, before the stability of the arch is determined; if, however, a curve such as that in diagram 5 could be traced, the property of which curve should be, that at any point in it the tangent should represent the position and direction of the resultant pressure, as the arrows $P_2$ $P_3$ $P_4$ $P_5$, which are tangents to the curve, and which also show the position and direction of the resultants; then if no part of this curve passed without the structure, or so near to the edges of it, as to cause the material to yield, the structure would be stable, however numerous, or in whatever direction the joints might be, provided that the perpendicular from the joint were inclined to the tangent to the curve, at an angle less than the limiting angle of resistance. This curve is known as the "line of resistance," and its properties were discussed for the first time by Professor Moseley, in essays published in the "Cambridge Philosophical Transactions;"* it can be traced by application of difficult mathematical analysis, as shown in the fourth part of the "Mechanical Principles of Civil Engineering and Architecture," p. 403. If, however, the resultant pressures are determined for a series of joints, the line of resistance can be traced with sufficient accuracy from joint to joint, by means of a bent whalebone, or a metal spring, or by hand as in diagram 5.

ART. 3. *Problem* 1.—To find the position, direction, and amount of the resultant pressure on every joint of a structure, the resultant pressure on one of the blocks being given in position, direction, and amount, and the specific gravity of the material forming the structure being also known.

Diagram 6 represents a structure of seven blocks of stone, or other material, the pressure on the first block being 80 cwt., and its position and direction represented by the arrow; it is required to determine the position, direction, and amount of the resultant pressures on all the other blocks.

Construct a scale of equal parts, each part to represent one cwt., or one pound, &c., as may be convenient. In this figure each equal part represents one cwt. Calculate the weight of each stone (*in this example, if the first block weighs* 15 *cwt., the weight of the others are as figured on them in the diagram*).

Find the centres of gravity of the blocks: (*they are indicated in this and the following diagrams by this mark* ⌖).

Then the pressures on the second block are, first, the weight of the first block = 15 cwt., which may be represented by a pressure of 15 cwt. acting vertically downwards through the centre of gravity of the block; draw the line $W_1$, representing the position and direction of this pressure: secondly, the pressure on the first block, which acts in the direction and position indicated by the arrow; continue this direction till the line intersects the vertical, through the centre of gravity; from the point of intersection of these two lines measure off, on the vertical line, a distance equal to 15 parts of the scale, making the side $W_1$ of the parallelogram; and on the line in the direction of the pressure on the block, measure off a distance equal to 80 parts of the scale, making the second side $P_1$ of the parallelogram; draw the other two sides; and the diagonal $R_1 W_1 P_1$, will represent the direction of the resultant of these pressures; its length, equal to 81½ parts of the scale, will give the amount of its pressure, 81½ cwt., and the line, continued till it intersects the joint No. 1, will represent the point of application of this resultant pressure on the second block; that is to say, that point will be the centre of pressure of all the pressures, communicated throughout the surfaces of contact, from the first block to the second, and the amount of the resultant, 81½ cwt., will be the aggregate of these pressures.

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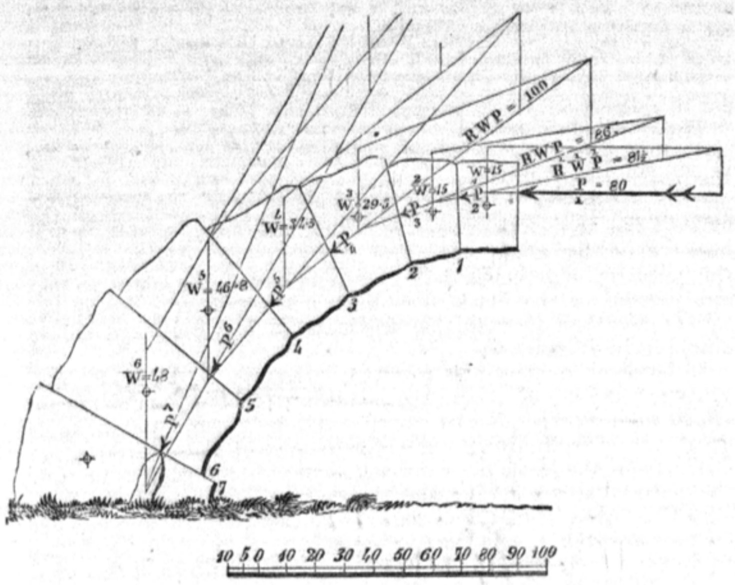
* Vide Phil. Trans., Cambridge, vol. v. p. 293; vol. vi. p. 463.

Diagram 6



Scale of equal parts, representing Cwts.

If the line $W_1$, representing the weight of the block, is drawn from the point of intersection, in the direction in which it acts, that is, vertically downwards, then the line $P_1$, representing the pressure on the block, must be drawn in the direction in which it acts, that is, from right to left. If, however, as in the present case, it is more convenient, the lines may be drawn each in the direction opposite to that in which the pressures act, that is, the weight represented by a line vertically upwards, and the pressure by a line from left to right, in which case the resultant pressure will act in the direction of the diagonal, but *towards* the point of intersection of the two lines, that is, from right to left in the present example.

The resultant pressure on the third block is determined in a manner precisely similar to that described above, with regard to the second; a vertical line is drawn through the centre of gravity of the second block, and the direction of the resultant pressure on the same, $P_2$, is continued till the lines intersect; 81½ parts measured from this intersection on the latter line, form one side of the parallelogram, and 15 parts measured on the vertical line from the other, for the amount of the resultant pressure on the second block is 81½ cwt., and the weight of the second block is 15 cwt.: the parallelogram being completed, the diagonal produced determines the position and direction of the resultant pressure on the third block, and its length, measured by the scale, determines the amount of the pressure to be 86 cwt. In like manner, the pressure on the fourth block is 100 cwt., and its position and direction are shown by the arrow $P_4$; also $P_5$ $P_6$ $P_7$, show the position and direction of the resultant pressures on the fifth, sixth, and seventh blocks, and their respective amounts are determined by the length of the diagonals of the fourth, fifth, and sixth parallelograms, and if any of the blocks were removed, and replaced by a prop, in the position and direction shown by the arrow: as for example, if the seventh block were removed, and replaced by the prop there shown, then all the remaining portion of the structure would be balanced on the point of the prop. Each of these arrows are tangents to the line of resistance, which can be drawn from point to point by the eye, or by means of a piece of whalebone, or a metal spring.

If, instead of the pressure on the first block, the pressure on any other block be given, the resultant pressure on all the others may be found in a similar manner. Thus, if the pressure on the fourth block is known, the pressure on the fifth, sixth, and seventh will be found in precisely the same manner as above described. Then with regard to the third block, it will be acted on by its own weight, and the pressure from the second block, and the given pressure on the fourth block, is the resultant of these two pressures; if, therefore, a vertical line is drawn through the centre of gravity of the third block, and another line is drawn in the direction of the given pressure on the fourth block, and from the point of intersection of these two lines there is measured off on the vertical, as many parts of the scale as there are cwts. in the weight of the block, and on the other line, as many parts as there are cwts. in the given pressure on the fourth block; then there have been measured the side $W_3$ of the parallelogram and the diagonal $R_3 W_3 P_3$, and these two lines determine the parallelogram, the second side of which, from the point of intersection, represents the pressure on the third block. This pressure on the third block being determined, that on the second and that on the first block may be found in the same manner, the lines drawn being the same as those in the example.

Art. 4.—In nearly all cases of arched structures, the pressure on any one of the voussoirs is unknown, and this constitutes the difficulty of the subject: the point of application, the direction, and the amount of the resultant pressure on any of the voussoirs being determined, the conditions of stability of the whole structure are found by the application of the foregoing problem. To determine the stability of the arch with regard to the first condition of failure, diagram 2, that is, supposing failure to take place, by the slipping of one vouissoir on another, the direction only of the resultant pressures is required; but to determine whether the arch will fail (as in diagrams 3 or 4), by the voussoirs turning on their edges, or by the material failing, not only the direction, but the points of application and the amount of the pressures must be determined. The theories of the arch, which preceded that of Professor Moseley, take into consideration only the first condition of failure (Art. 1, diagram 2), it being supposed that if the arch failed, it would be by one of the voussoirs slipping on another. The experiments of Rennie, Morin, and others, had not then been made, and the resistance of the friction of one stone on another was much underrated, so that it was considered necessary for stability, that the direction of the pressures should always be perpendicular to the joints; of course this could only be the case for one particular system of pressures, and if the weights on the voussoirs and other pressures were so arranged, that the resultant pressure on each joint acted in a direction perpendicular to it, then if any weight were added to the system, or any taken away, the positions and directions of the resultant pressures would, of course, vary also, and their directions be no longer perpendicular to the joint. It seems to have been the practice of bridge-builders, to take the weight of the arch-stones and backing for the fixed system of pressures; and this weight being very great in proportion to that of the wagons, carriages, and people passing over, the effect of the latter was not an important consideration, and the old problems sufficiently answered the purpose. In the case, however, of a light railway bridge, traversed by a heavy train, which, coming upon it suddenly, has twice the effect of a stationary pressure of the same weight, the effect of such traffic must not be omitted from the calculation; but if the arch is designed and the weights on the voussoirs arranged, so that the resultant pressures shall be perpendicular to the joints when the train is on the bridge, then, when the train has moved off, all the resultant pressures will have taken new positions and directions, no longer perpendicular to the joints; so that, according to the theories themselves, the arch would fail. These theories are also quite useless in determining the stability of vaults on high walls; there is not, perhaps, a single vaulted roof now standing, that does not prove their fallacy.

Art. 5.—Without taking into consideration the adhesion of the cement in the joints, the limiting angle of resistance for the surfaces of all materials used in arches, is so large, that it would be difficult to design an arch and loading, in which the first condition of failure would be fulfilled; in the pier or abutment, however, such failure is likely to occur, and must be carefully guarded against.

The second condition of failure, diagram 3, is, strictly speaking, impossible, for no block will turn on its edge upon another, without some abrasion, or elastic yielding, of the surfaces, in which case it becomes that shown in diagram 4, or the third condition of failure; however, as the failure takes place from the tendency of the pressures to turn the blocks on their edges, it seems that the